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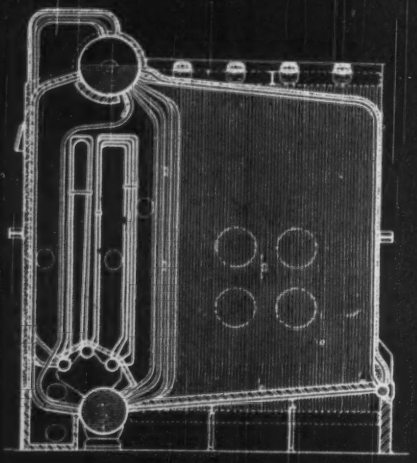
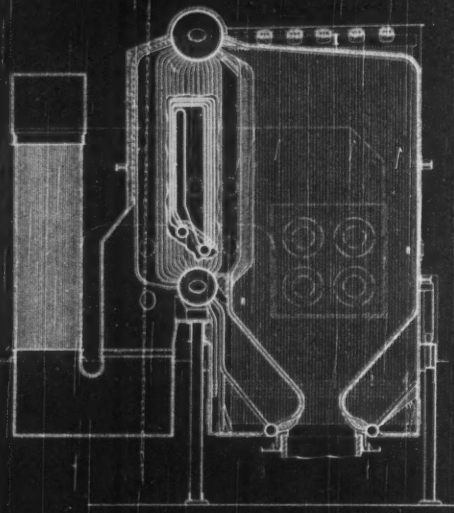
B&W INTEGRAL-FURNACE BOILER TYPE FH

Products of B&W Engineering for Economy



Process plant installation arranged to burn five fuels



Manufacturing plant installation arranged for coal-firing by B&W pulverizers

bringing NEW *Economies in Steam* to all industries

Manufacturing, process, and service industries, along with many power companies all over the U. S. A. are finding the ideal answer to their new steam requirements in the B&W Integral-Furnace Boiler, Type FH. Installations range in steam capacity up to 350,000 lb. per hr. per unit, employing a wide diversity of fuels and firing methods, pressures to 1050 psi, and temperatures to 910 F.

An important advance in steam engineering, this B&W unit brings together, in a modern, standardized design, all the best features of the original and highly successful Integral-Furnace Boiler, introduced by B&W 17 years ago, plus many additional improvements . . . each one time-tested and performance-proved.

Immediate and widespread acceptance—over 39 million pounds per hr. of steam capacity installed or ordered—is evidence that the Type FH Boiler satisfies all modern requirements for dependability, efficiency, accessability, adaptability, and economy of installation and operation. It will pay you, as it has so many others, to consult B&W engineers about this boiler when planning steam plant expansion or modernization.

COST SAVING FEATURES
OF B&W INTEGRAL-FURNACE BOILER, TYPE FH

HIGH AVAILABILITY, due to:
- Self-draining Superheater
- Continuous Ash Disposal
- Ease of Inspection
- Quick fuel changeover

HIGHLY DEPENDABLE, because of:
- Less Slagging
- Less Manual Cleaning
- Improved Soot Blowers
- Ease of Operation
- Improved Circulation: Clean, Dry Steam

HIGHLY ECONOMICAL, due to:
- Low Maintenance
- Minimum Space Requirements
- High Heat Absorption
- Fuel and Firing Flexibility

G-481

BABCOCK & WILCOX

Helping Industry Cut Steam Costs Since 1867

Seasoned troupe of

MONEY SAVERS

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NATIONAL TEXTILE SHOW

I ADAPT MYSELF TO ANY SHAFT
MY OIL-CIRCULATING SYSTEM IS BUILT IN
I PUMP AND CIRCULATE THE OIL I NEED
I FILTER AND STORE THE OIL I NEED
I REDUCE "FLASH" FIRES IN TREADLE ROLLS
MY OIL IS RENEWED BY "HYPO" INJECTION

THIS MONTH at Atlantic City the great and growing textile industry stages its National Show, to present the latest and best in processes and equipment.

Illustrated here are six ball bearings, typical of the many originated and developed by New Departure. They will be on display at the New Departure exhibit where visiting designers and engineers customarily spend much of their time.

And no wonder! For most of the advances in ball bearing design for textile machinery these last ten years came from New Departure. Engineering literature, descriptive of them, will be mailed promptly to requests on business letterheads.

Nothing Rolls Like a Ball... **NEW DEPARTURE BALL BEARINGS** 93

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

MECHANICAL ENGINEERING, May, 1950, Vol. 72, No. 5. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price 75¢ a copy, $7.00 a year; to members and affiliates, 50¢ a copy, $4.00 a year. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the act of March 3, 1879. Member of the Audit Bureau of Circulations.

"Buffalo" Limit-Load Fan and Air Washer cleaning foundry air.

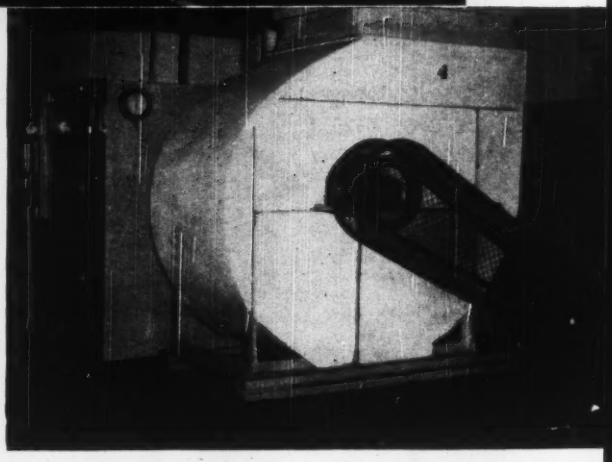
How You Can Put Your AIR TO BEST USE

"Buffalo" AIR CONDITIONING Can Do A *Complete* Processing Job

The industrial uses of air multiply daily! It's the recognized "comfort medium" that makes workers more efficient and productive. It's a "safety factor" which can minimize explosion dangers, fume poisoning and risk of "accident-prone" workers. *It can control your product quality, your turnout—and your profits—to a remarkable degree* And present-day "Buffalo" Air Conditioning Units can create and maintain *any* air condition you require. You can wash your air, heat or cool it as desired, control the humidity exactly, collect dust by-products from your air—easily, continuously and economically—with "Buffalo" equipment.

"Buffalo" FANS Often The Only "AIR CONDITIONING" You Need

Modern, efficient fans perform many of the functions of air conditioning. A "Buffalo" Limit-Load Fan, for instance, can "cool by ventilation"—circulating air continuously throughout the plant and causing a cool, comfortable feeling. "Buffalo" Fans can remove harmful dust, fumes and excessive moisture from your plant air. In these and dozens of other ways, "Buffalo" Fans can put your air to profitable use.



"Buffalo" "LL" Fan and Comfort Conditioning Cabinet supplying conditioned air in a large office building.

It Costs You Less Than You'd Think

"Buffalo" equipment is permanent equipment. Flimsy, light-weight "package" units are not part of our line. The results? Many "Buffalo" air washers are still giving efficient daily service over FORTY YEARS AFTER INSTALLATION. Many "Buffalo" Fans are OVER FIFTY YEARS OLD. Here, certainly, is long-run economy! Why not talk over YOUR air and its profit possibilities with a trained "Buffalo" engineer? Write us—we'll have him call on you AT NO OBLIGATION!

BUFFALO FORGE COMPANY

148 MORTIMER ST. BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

Branch Offices in All Principal Cities

New... A DEVELOPMENT OF 92 YEARS' EXPERIENCE

All phases of operation of the press are from a single, compact control console which may be located at the most convenient point near the press. The control may be either push-button for automatic cycling, or lever operated manual control. Any press operation can be stopped *instantly*.

ROBERTSON

"Packaged"

OIL - HYDRAULIC LEAD ENCASING PRESS

Compactness is the key-note in the design of this new press . . . for it is indeed a "packaged" unit, incorporating in a single construction the pump, drive, valves, speed control devices, oil reservoir, etc. This not only results in saving floor space but keeps major pressure lines short and direct.

Robertson's standard of rugged construction has been maintained throughout to assure maximum servicability. The use of oil for the hydraulic fluid provides perfect lubrication and longer life of working parts.

A wide margin of safety is provided in the pump which is designed for 7000 p.s.i. although only 6000 p.s.i. pressure is normally used.

For a press with maximum efficiency and dependability and minimum maintenance . . . investigate the new Robertson "Packaged" Oil-Hydraulic Lead Encasing Press.

SEND FOR LITERATURE.

Robertson
COMPANY, INCORPORATED

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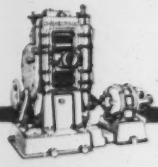
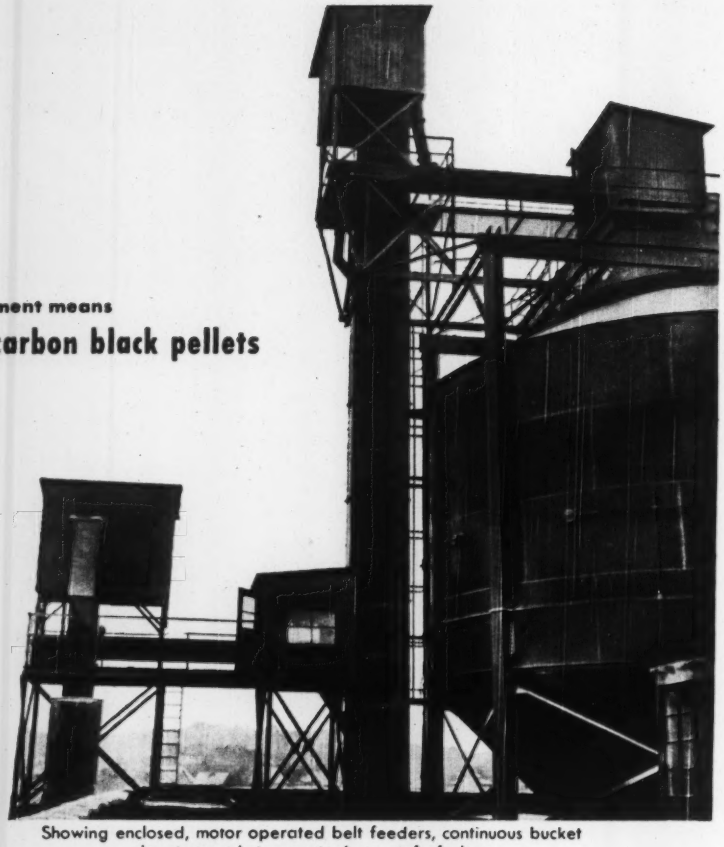
Designers and Builders of all Types of Lead Encasing Machinery
Since 1858



Lead Sheath Stripping Machine

smoother riding
—on G-W bulk handling equipment means
less "break-up" for carbon black pellets



Showing enclosed, motor operated belt feeders, continuous bucket elevators and storage tank on roof of plant.

Slow speed continuous bucket elevator carries pellets from conveyor beneath track level to roof storage.

Unloading from one of the hopper ports through the automatic car sealing valve.

Materials handling systems for bulk chemicals is a G-W specialty. A typical example is the system illustrated here for conveying and elevating pelletized carbon black from hopper car to process. Advantages of this type of installation are many, some of which are:

1—**Carbon black dust is virtually eliminated since the system is completely enclosed from automatic car sealing valves through storage bin to process.**
2—**Valuable floor space is released since bulk storage can be located on roof or any other outside point.**
3—**Handling is automatic which eliminates up to four separate handling operations, necessary when carbon black is used in non-pelletized form.**
4—**One man can unload a full car in less than six hours, his only manual effort being to fasten unloading chutes to car ports.**

If you have a problem handling chemicals in bulk, be it carbon black, soda ash, sodium sulphate, chrome ore, bauxite, etc., consult a G-W Materials Handling Engineer. He is backed by 136 years of engineering design and knowledge in the materials handling field. His recommendations, drawn from this extensive experience can point the way to more economical movement and storage of materials in your plant.

GIFFORD-WOOD CO.

Since 1814

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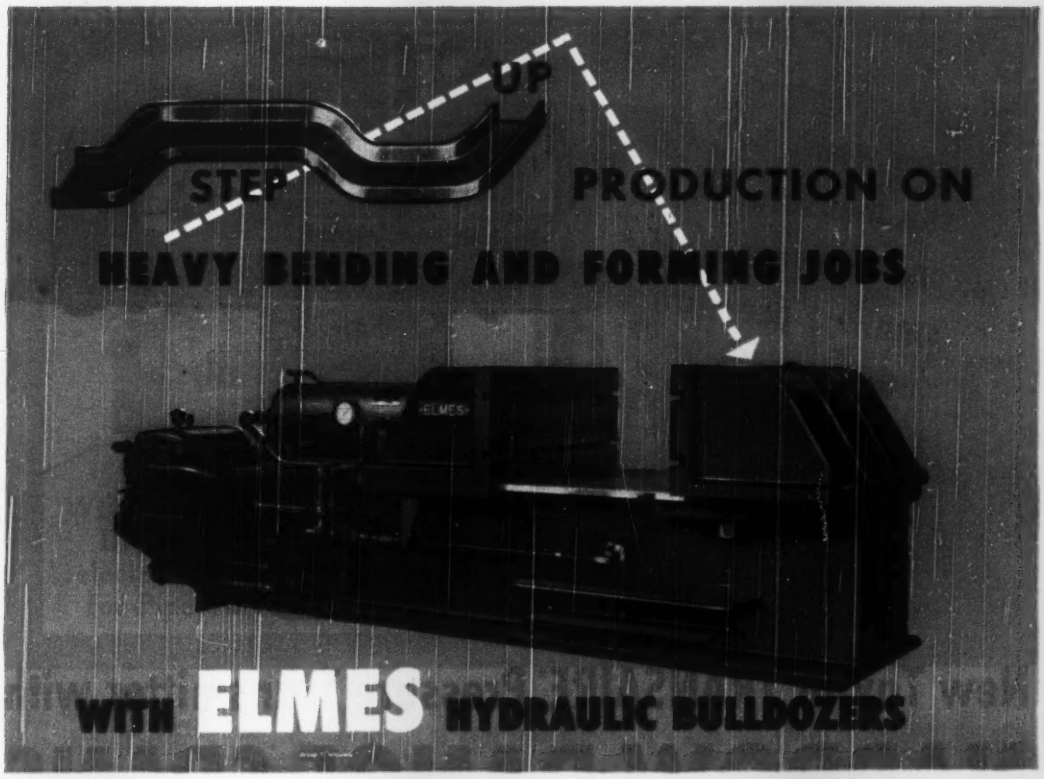
420 LEXINGTON AVE. NEW YORK 17, N. Y. | RAILWAY EXCHANGE BUILDING ST. LOUIS 1, MO. | 565 W. WASHINGTON ST. CHICAGO 6, ILL.

WHEN YOU THINK OF MATERIALS HANDLING — THINK OF GIFFORD-WOOD



Here is a highly *versatile* Elmes Hydraulic Press that will save you both *time* and *money* on heavy bending and forming operations. The controlled, cushioned squeeze of Elmes hydraulic power eliminates pre-setting or re-setting of press stroke for (1) job changes, (2) variations in stock size. To change jobs—just change dies! Full pressure can be applied at any point in the stroke and length of stroke can be varied to suit the individual job.

Elmes Hydraulic Bulldozers are available in both standard and special designs to meet any capacity requirement. Bed size, stroke and speed are optional to suit your service needs.

These presses have T-slots in platen and resistance head for mounting dies. Resistance head is adjustable for close-gap work. Other standard features are fixed stop reversal, extra-long removable guides on platen, sensitive tip-toe control, high-speed operation. Pumping unit is located on end of press, for protection against overhead traveling materials.

For nearly a century, Elmes hydraulic equipment has solved the pressing problems of industry. Why not ask Elmes to assist in the selection or design of the right metal-working press for *your* production? Recommendations and cost estimates are yours for the asking!

Write for Bulletin 1010-B, "Hydraulic Metal-Working Presses."

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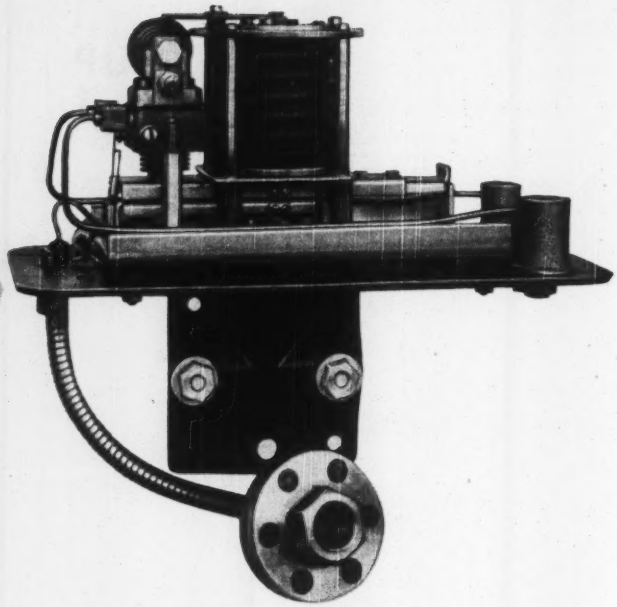
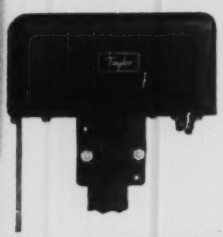
Now you can measure and transmit smallest pressure changes with TAYLOR ACCURACY!



New Taylor TRANSAIRE* Pressure Transmitter with NARROW RANGE SPANS



FIRST TIME in history! A simple force-balance pressure instrument that measures and transmits the smallest pressure changes up to 1000 ft. with an accuracy of ½% of the range span (*conventional devices are only accurate up to ½% of upper range limit.*)

Taylor's new TRANSAIRE Pressure Transmitter gives you accuracy and sensitivity never before possible in pressure measurement—plus the convenience of suppressed ranges at high pressure levels.

SEVEN IMPORTANT ADVANTAGES:

1. RANGE SPANS OF 20 AND 40 PSI available throughout range limits of 35 to 415 psia. With accuracy established at ½% range span, you can expect precise measurement to .1 psi with 20 psi spans, and .2 psi with 40 psi spans—and consequently proportionately closer control.

2. VOLUMETRIC TYPE PRESSURE SYSTEM is extremely accurate. Being a completely closed system there is practically no hazard of clogging. Type 316 stainless steel diaphragm and connection give maximum corrosion resistance.

3. PERFECT FOR MANY JOBS, especially on thin fractionating columns in chemical and petroleum industries, etc.

4. STANDARDIZED 3 TO 15 PSI OUTPUT Air Pressure means you don't have to individually calibrate receivers or receiver-controllers. Instrument transmits output pressure in proportion to measured pressure with accuracy of ±0.06 psi.

5. OPERATING RANGE VARIED by simple screwdriver adjustment.

6. INTERCHANGEABLE MANIFOLD ASSEMBLIES make 20 and 40 psi range spans optional.

7. INSTRUMENT QUICKLY TRANSFERRED from one job to another having different range by simply inter-changing spring sub-assemblies.

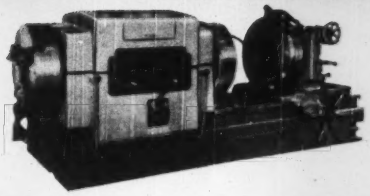
This Taylor TRANSAIRE Pressure Transmitter is another step in Taylor's program to produce industrial instrumentation unsurpassed in *accuracy*, *simplicity*, and *durability*. We're doing this, of course, to help you keep costs down and quality up. Ask your Taylor Field Engineer! Or write for **BULLETIN 98099.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.

* Trade-Mark

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

AUTOMATIC SHEAVES



WILLIAMS TOOL COMPANY, Brantford, Ontario, Canada selects Texrope Automatic Sheave for Pipe Threading Machines!

Give Efficient, Accurate Machine Tool Speeds!

HERE'S ANOTHER EXAMPLE of the versatility of *Texrope* Automatic Sheaves! Instantly *stepless* speed variations were required on these pipe threading machines to match the diameter and type of material being threaded.

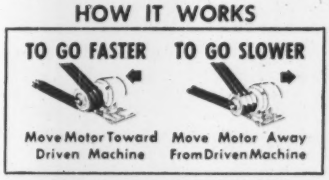
After considering many other means, Williams Tool Company installed a 2-groove R Section Vari-Pitch Automatic Sheave with 5.25 in. to 10.0 in. pitch diameter and a 7.2 in. pd companion sheave with clutch built into the hub.

This combination, plus a four-speed transmission gives them stepless speeds of 5.95 rpm to 34.7 rpm. And, because of the small size of the drive, it mounts in the small available space without change in machine design!

GET BROAD APPLICATION

Vari-Pitch Automatic sheaves can replace almost any standard sheave on drives from 1½ to 40 hp (special to 60 hp) . . . will give you *stepless* speed changes in a matter of seconds . . . overall speed ratios of as high as 2 to 1.

HOW IT WORKS



CHANGE SPEED WITH ONE HAND WHILE MOTOR IS RUNNING

For complete information on diameters and number of grooves, send coupon or check with your nearest A-C Sales Office or Authorized Dealer.

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- ☐ 1. *Vari-Pitch* Automatic Sheaves — Section 20-P-50 (Part 4)
- ☐ 2. Handy Guide for Quick Selection of standard *Texrope* Drives — Bulletin (20B6051)

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DIAMOND CHAIN Long-Life Accuracy Helps Keep Output Up

● Where profit per unit is microscopic—the net is gained through assured steady top output. Delays for any reason must be avoided.

In the wrapping of thousands of loaves of bread per hour, the machines must operate unfailingly with clockwork precision. On such machines Diamond Roller Chains prove again the importance of their uniform high quality, efficiency and reliability of performance.

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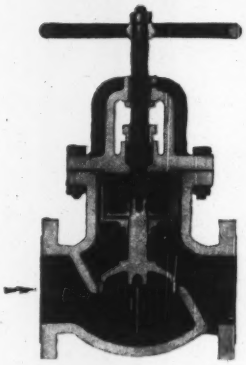
SAVE MONEY IN YOUR PLANT

—with FOSTER AUTOMATIC VALVES



FOSTER AUTOMATIC NON-RETURN Stop and Check Valve, Type 2

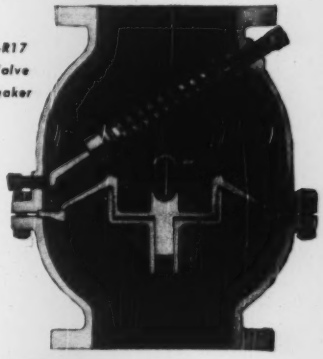
A . . . On your boiler drums, Foster Automatic Non-Return, Stop and Check Valves save money by doing their job perfectly—with the absolute minimum of attention—for years. It is not unusual to find these valves still giving good service after 25 or 30 years and more. Today's valves are even better.

There's nothing skimpy about a Foster Type 2. Full pipe area means negligible pressure drop across the valve. Heavy duty, through bolted construction makes it safe to work under when the boiler is down. Low pressure types to 250 lbs. (stocked) have semi-steel bodies, bronze trimmed, with stainless steel seat rings; high pressure types to 1,500 lbs. have cast steel bodies, trimmed with special heat resisting, corrosion resisting alloys. Piston chambers are renewable. They're built for lifetime service. Globe, angle, or elbow, from 2½" to 12".

Z . . . The R-17 Back Pressure Valve saves money by keeping the pressure where you want it on the exhaust side—for your feed water heater or other low pressure equipment—with a minimum of maintenance. Large pipe area, and large valve area mean low pressure drop across the valve, and sensitive action at low pressures. Saves make-up steam. Adjustable in ounces.

The R-17 has no outside stuffing boxes or external weights. Loading spring is on the atmosphere side of the valve and is accessible for inspection through a large handhole. Renewable seat ring and dash pot. 2½" to 20", (with sizes from 4" to 12" stocked).

Foster Type 34-R17 Back Pressure Valve and Vacuum Breaker



• • • All along the line—Foster Pressure Regulators, Temperature Regulators, Pump Governors, Float Valves, Safety Valves, Check Valves, Relief Valves and Safety Valves are designed and built to save money, by giving reliable, trouble free regulation with a minimum of maintenance. When you select the proper Foster Valve and install it correctly, you are making a sound investment, backed by more than 70 years of practical experience in building good valves, and our reputation for service.

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PRESSURE REGULATORS . . . RELIEF AND BACK PRESSURE VALVES . . . CUSHION CHECK VALVES . . . ALTITUDE VALVES . . . FAN ENGINE REGULATORS . . . PUMP GOVERNORS . . . TEMPERATURE REGULATORS . . . FLOAT AND LEVER BALANCED VALVES . . . NON-RETURN VALVES . . . VACUUM REGULATORS OR BREAKERS . . . STRAINERS . . . SAFETY VALVES . . . SIRENS

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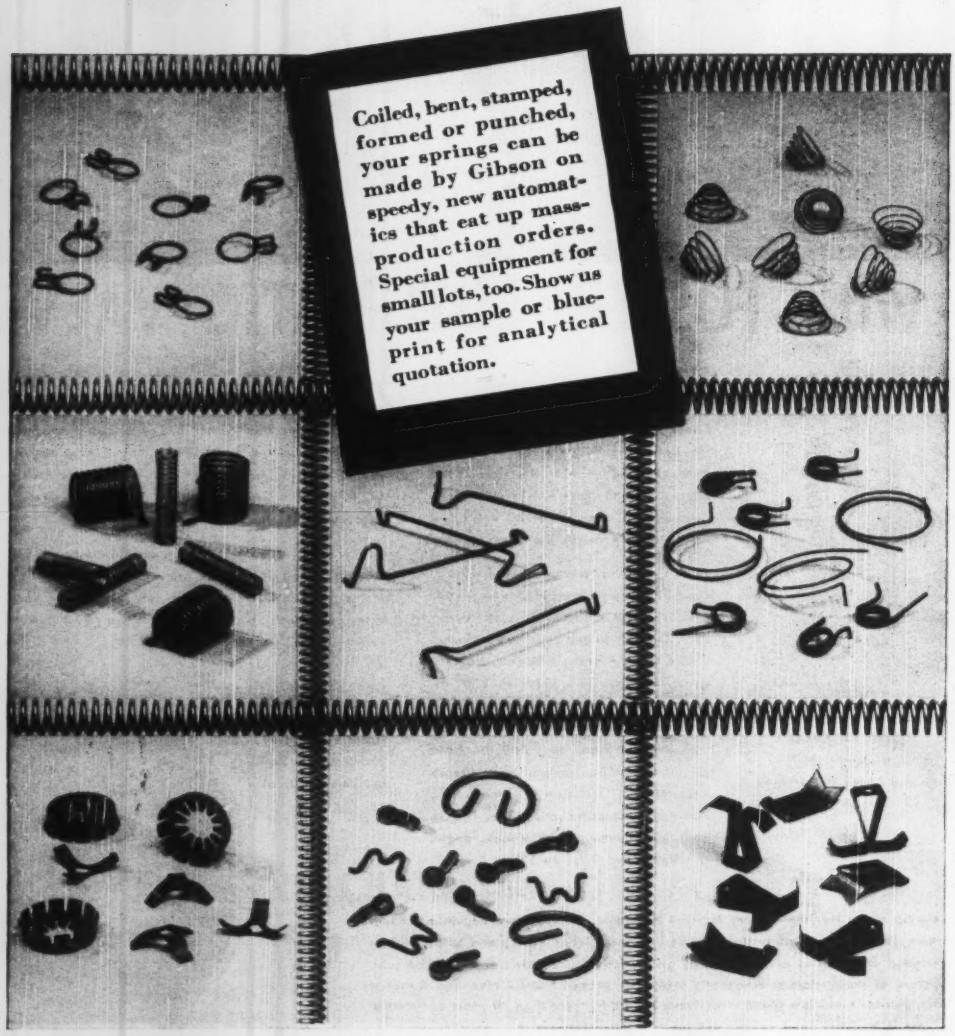
SMALL SPRINGS IN A BIG WAY!


Coiled, bent, stamped, formed or punched, your springs can be made by Gibson on speedy, new automatics that eat up mass-production orders. Special equipment for small lots, too. Show us your sample or blueprint for analytical quotation.

SMOOTH ACTING

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DIVISION OF ASSOCIATED SPRING CORP.

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CLAMPS · WIRE FORMS

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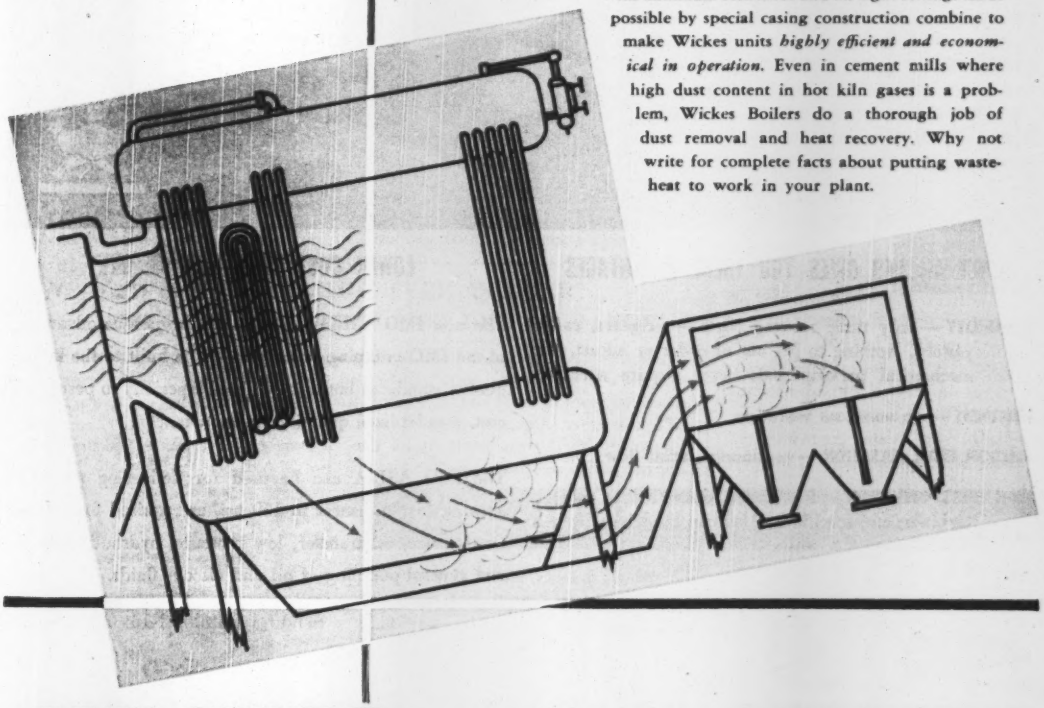
HARNESS WASTE HORSEPOWER WITH

WICKES WASTE-HEAT BOILERS

CONVERT WASTE-HEAT into PROFITABLE POWER

Waste heat, once discharged from manufacturing equipment as a loss, has been made to realize a high economic return through the installation of Wickes Waste-Heat Boilers. In actual cases, the reduction in the costs of manufactured products has *paid for the waste-heat installation* within 2-3 years time, and in some industries, heat recovery is sufficient to produce all steam and power required.

Wickes Boilers are correctly designed and built to effect maximum heat recovery from all types of waste gases. High gas velocity, long gas travel with minimum resistance and air-tight settings made possible by special casing construction combine to make Wickes units *highly efficient and economical in operation.* Even in cement mills where high dust content in hot kiln gases is a problem, Wickes Boilers do a thorough job of dust removal and heat recovery. Why not write for complete facts about putting waste-heat to work in your plant.



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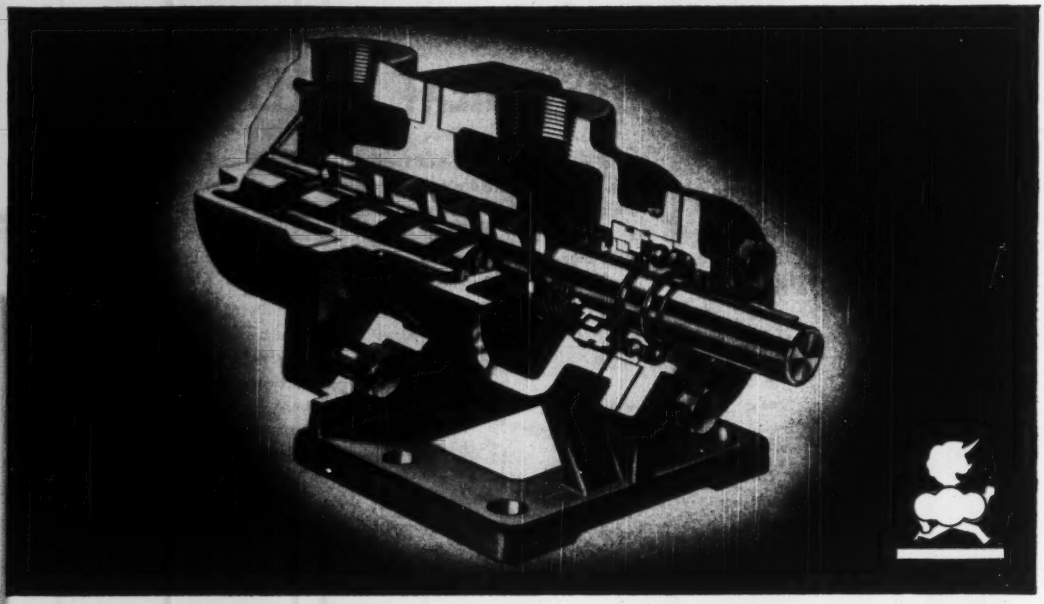
A NEW IMO PUMP AT LOWER COST THAN EVER BEFORE!



ONLY AN IMO GIVES YOU THESE ADVANTAGES

RELIABILITY — only three moving parts — no gears, vanes, pistons. Nothing to get out of order or adjust. The mechanical packing seals never require attention.

QUIETNESS — no noise, no vibration.

FREEDOM FROM PULSATION — continuous, axial flow.

HIGH SPEED OPERATION — for direct connection to motors, turbines, and machines. Also can be driven by belt or chain.

LOWER COST THAN EVER BEFORE

The new IMO A313A possesses all the unique advantages of the IMO pumping principle — it is built to the highest quality standards but it is designed especially to permit low cost, standardized quantity production.

The IMO A313A can be used for delivering up to 80 gpm against pressures to 150 psi, as required for lubrication service, oil transfer, low pressure, hydraulic systems, and general pumping of oil and viscous fluids.

Send for Catalog I-159-A.

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I-159

BIDDLE *Instrument News*

- ELECTRICAL TESTING INSTRUMENTS
- SPEED MEASURING INSTRUMENTS
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NUMBER 1 OF A SERIES

JAMES G. BIDDLE CO., 1316 ARCH ST., PHILADELPHIA 7, PA.

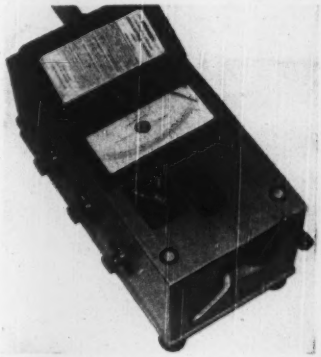
UP TO 50,000 MEGOHMS WITH *NEW* MEGGER® INSULATION TESTER

***New* Higher Ranges**
Wider Ranges
Longer Scales
***Improved* Mechanical Features**

Never before has the direct-indicating cross-coil ohmmeter been capable of measuring such high values of insulation resistance!

This accomplishment comes at a time when more attention than ever is being focused by engineers on insulation resistance or d-c loss measurements as a practical non-destructive means of forestalling breakdown in electrical equipment.

These new sets include also several important improvements, such as static shielding, improved hand-drive mechanism, and a simplified design for motor-drive with better voltage stabilization.



The new line of Megger Insulation Testers is now available in the following ranges:

Volts	*Inner Scale Megohms*	*Outer Scale Megohms*
500 volts d-c	0 to 50	3 to 10,000
1000 volts d-c	0 to 100	6 to 20,000
2500 volts d-c	0 to 200	15 to 50,000

For description and prices, *write for Bulletin 21-20-M.* Check coupon below.

A *NEW* CONSTANT-VOLTAGE TYPE MEGGER® INSULATION TESTER IN THE LOW-PRICED RANGE

The trim, modern design of this newcomer to the Megger family of insulation resistance testing instruments is only part of the story. Ohm scale and selector switch are available on all instruments in ranges of 0 to 10 megohms, 100 volts d-c, 0 to 20 megohms, 250 volts d-c, 0 to 50 megohms, 500 volts d-c. The constant-voltage feature is standard with all of these new CVM (Constant Voltage Type Megger) Insulation Testers. These features plus several other mechanical refinements contribute to make this instrument a worthy addition to the popular line of Megger Instruments.

Bulletin 21-80-M, describing this instrument, will be sent on request. Check the coupon at right.

THE T-21 MEASURES SPEED SIMPLY BY TOUCH—OR BY MOUNTING ON MACHINE

This new low-priced, miniature FRAHM® Resonant Reed Tachometer is available singly or in kits of three instruments; for hand use or permanent mounting; in ranges from 900 to 13,000 rpm, higher ranges on request.

The T-21 has the advantage of being small and easy to use as a pocket or tool kit instrument and yet easy to read when mounted on a machine. It has no parts to wear out, needs no maintenance, imposes no load on the machine under test, nor can it be damaged by overspeeding.

The simplicity of this resonant reed instrument in no way affects its accuracy—Frahm Tachometers are guaranteed to within 0.5% of their rated frequency of vibration.

For full details on the T-21 Frahm Tachometer, *write for Bulletin 31-35-M* or check coupon below.

Is Your LITERATURE FILE *Up to Date?*

James G. Biddle Company
1316 Arch Street, Philadelphia 7, Pa.

Please mail detailed literature as circled below:

21-20-M 21-80-M 31-35-M

(Please Print)

Name _____

Job Function _____

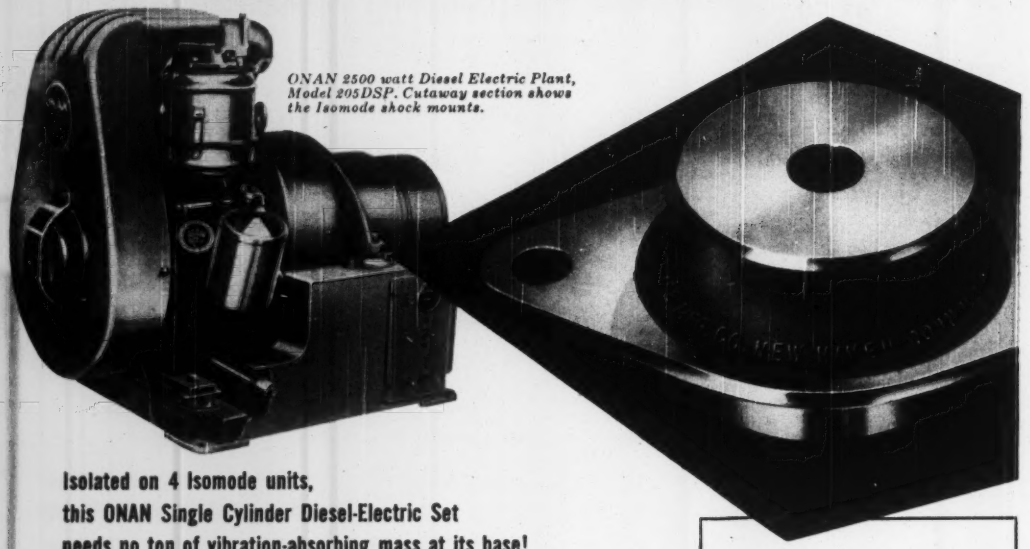
Company _____

Address _____

City _____ Zone _____ State _____

For better damping and easier installation . . .

ONE-CYLINDER DIESEL'S VIBRATION CONTROLLED WITH ISOMODE* MOUNTS



ONAN 2500 watt Diesel Electric Plant, Model 205DSP. Cutaway section shows the Isomode shock mounts.

Isolated on 4 Isomode units, this ONAN Single Cylinder Diesel-Electric Set needs no ton of vibration-absorbing mass at its base!

Single-cylinder Diesels, due to large unbalanced inertia forces, present a tough problem in vibration. In fact, without suitable isolation, such a power plant usually requires a massive foundation to control the destructive vibrations. Faced with this problem, Onan engineers rigorously tested a number of vibration isolators in a search for the right answer.

And they found it, to their complete satisfaction—in Isomode mounts. Not only did these units provide outstanding damping of motion, but they allowed easy installation on the generator set as well! The four Isomode isolators permit this electric plant to be bolted directly to the floor. Moreover, because they're uniformly flexible in all directions, these mounts also reduce strains on engine parts.

This typical case once again demonstrates the advantages of using the mounts with *equal spring rates in all directions*—MB mounts. More and more designers are discovering how they give improved isolation, last longer—and often simplify mounting bracket design and installation. In these units you may find the solution to your own problem, too. Write us. Our engineers will gladly go over your requirements with you.

**Trade Mark Reg. U.S. Pat. Off.*

THE ADVANTAGES OF designing with ISOMODE MOUNTS

- ✓ *They absorb vibration equally well in all directions* — vertical, as well as troublesome horizontal and rocking motions.
- ✓ *Non-directional* — can be mounted at any angle, in any direction, simplifying design problems.
- ✓ *High load capacity* in compact size — saving space, weight.
- ✓ *Large rubber volume* for softness — yet perfectly stable and self-snubbing.

SEND FOR THIS BULLETIN which gives details on a number of products that can help you with your vibration problems. Write for bulletin No. 410-J4.

THE MB MANUFACTURING COMPANY, INC.
1060 State Street, New Haven 11, Conn.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION . . . TO DETECT IT . . . TO REPRODUCE IT

New BRUSH Dual Channel DC Amplifier simplifies current-voltage studies

To measure and record two phenomena simultaneously, Brush introduces the new Model BL-928 Dual Channel Direct Coupled Amplifier for use with the Model BL-202 Dual Channel Magnetic Oscillograph. These Brush instruments, shown above, are being used in the test laboratory of Hertner Electric Company, Cleveland, Ohio to study the characteristics of motor-generators. In this particular test, they are recording generator voltage and field current time-curves for plotting a saturation curve and studying build-up of voltage. This requires only a few minutes . . . compared to the hours needed for conventional plotting methods.

These Brush dual-channel instruments can simplify the study of many other variables such as battery characteristics, photo cell outputs, line voltage and current values and electric phenomena having amplitudes of 40 millivolts or more and frequency components from zero to 100 cycles per second. Write for Form 732 which gives further details.

THE *Brush* DEVELOPMENT COMPANY

3405 Perkins Avenue, Cleveland 14, Ohio, U. S. A.

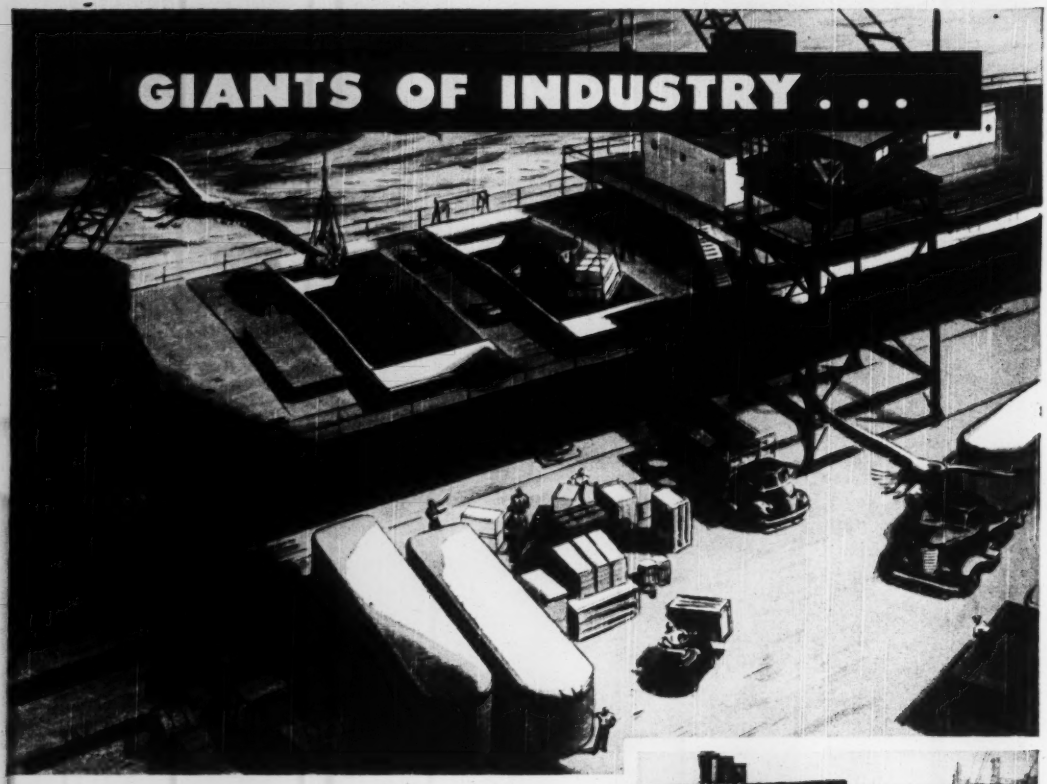
Canadian Representatives: A. C. Wickman (Canada) Ltd., P. O. Box 9 Station N, Toronto 14, Ontario

it in writing with a

BRUSH RECORDING ANALYZER

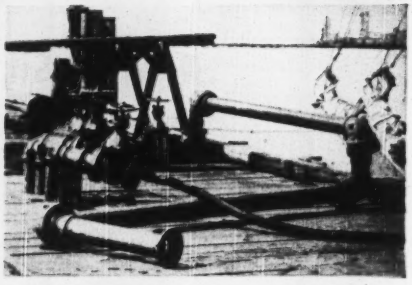
STRAIN ANALYZERS • SURFACE ANALYZERS • CONTOUR ANALYZERS • UNIVERSAL ANALYZERS • UNIFORMITY ANALYZERS

GIANTS OF INDUSTRY . . .



. . . AND BARCO JOINTS KEEP THE FLUID LINES *FLEXIBLE*

Because there is always movement—vibration, expansion, contraction—in any fluid-conveying system, Barco Flexible Joints are needed to provide responsive, compensating movement through every angle. Everywhere in industry and transportation, you will find Barco protecting the arterial systems which convey oil, gasoline, air, water, steam—the life-blood of America's industrial body. For more complete engineering information, write to Barco Manufacturing Co., 1807F Winnemac Ave., Chicago 40, Illinois. In Canada: The Holden Co., Ltd., Montreal, Can.



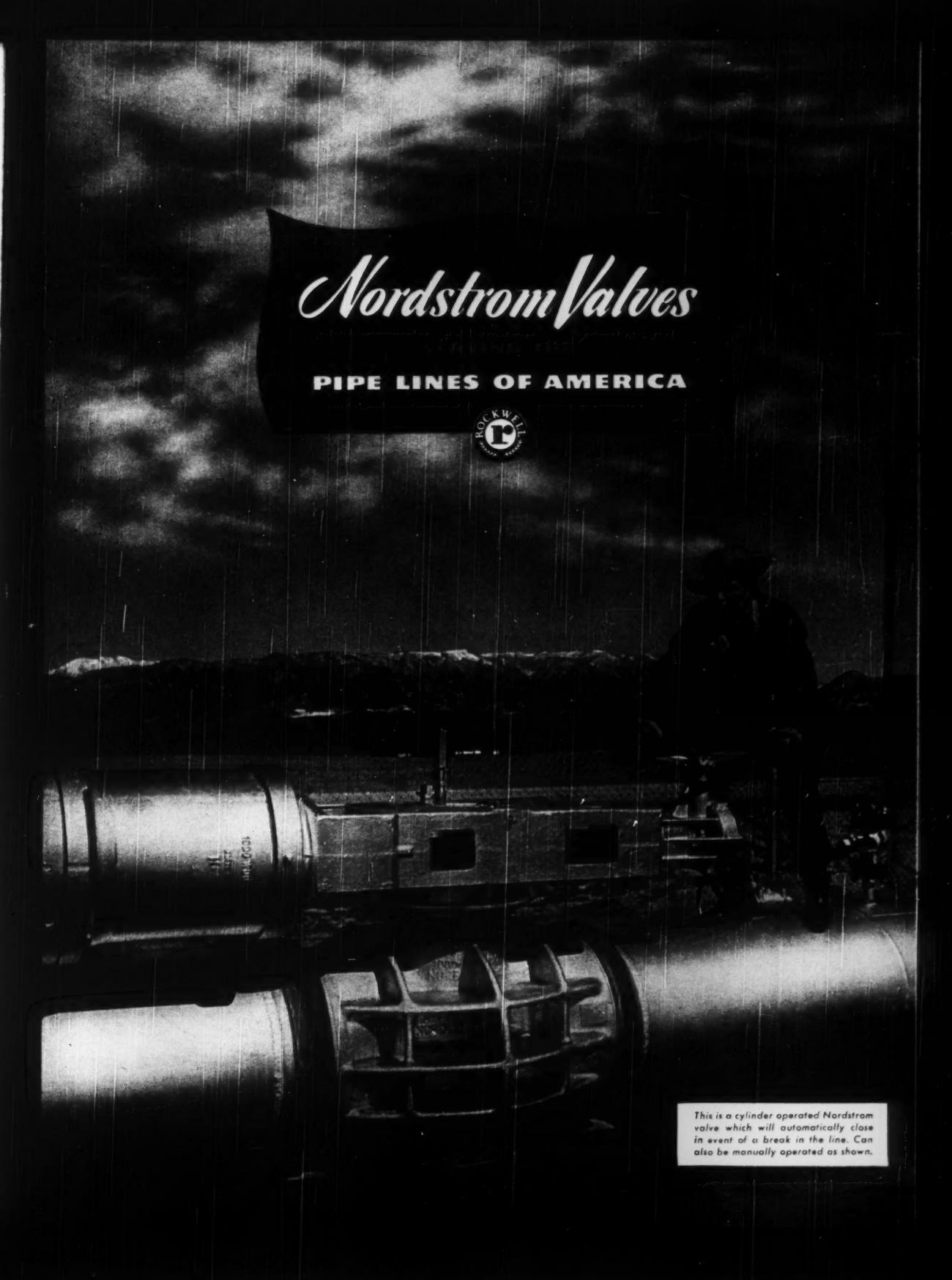
BARCO JOINTS ON WHARF LOADING LINES combine complete flexibility with long life. Also Barco Joints on loading and unloading lines are available in magnesium which permits extreme ease of handling because of their light weight.

BARCO *FLEXIBLE JOINTS*

Not just a swivel joint . . . but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

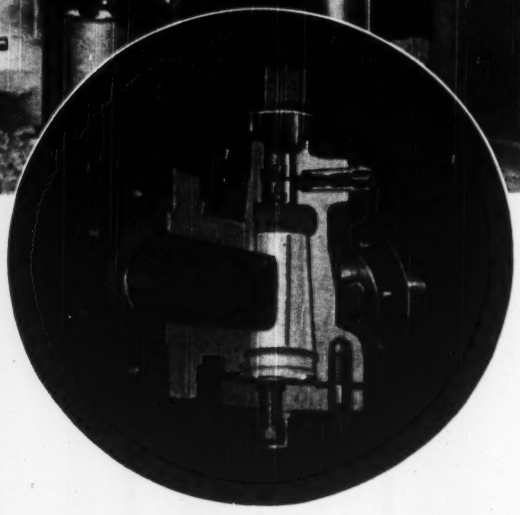
FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

"MOVE IN EVERY DIRECTION"



This is a cylinder operated Nordstrom valve which will automatically close in event of a break in the line. Can also be manually operated as shown.

GAS CONTROL engineered with foresight



MAJOR VALVES IN MAJOR SERVICES

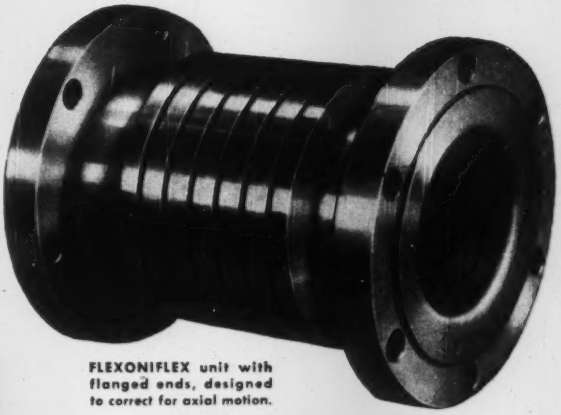
It's the *know how* of designing and making high pressure valves that counts. Given the toughest valve problems of virtually every industry, Nordstrom valve engineers have attained standards far beyond those normally set by industry. As examples: (1) pressures to 15,000-lb test; (2) temperatures to 1000° F; (3) development of brittle-resistant alloys for sub-zero service; (4) Merchrome coating of more than file-hardness to resist corrosion and abrasion; (5) large size designs up to 54-inch; (6) a full line of lubricants; and (7) automatic lubrication by use of Hypermatic lubricant. Nordstrom leads the field.

Nordstrom VALVES

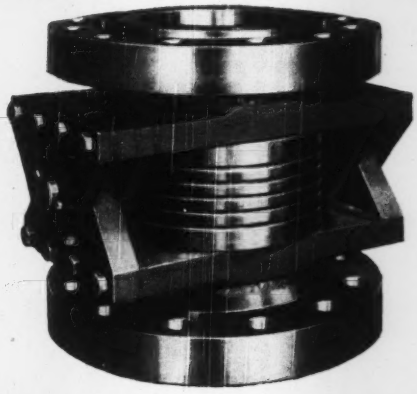
ROCKWELL

Nordstrom Valve Division
ROCKWELL MANUFACTURING CO.
400 N. Lexington Ave., Pittsburgh 8, Pa.
District offices in all principal cities

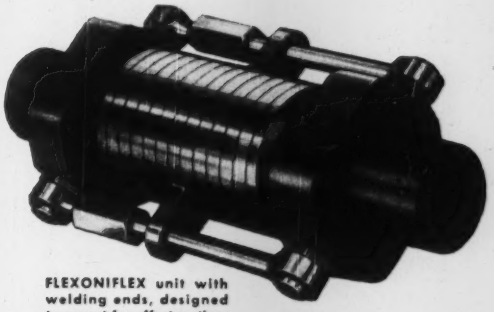
CMH Flexoniflex EXPANSION JOINTS



FLEXONIFLEX unit with flanged ends, designed to correct for axial motion.



FLEXONIFLEX unit with flanged ends, designed to correct for radial motion.



FLEXONIFLEX unit with welding ends, designed to correct for offset motion.

Proved-in-service Motion Control for the 1500 psi Pressure Range

Axial, offset and radial motion in high pressure piping systems is effectively absorbed by CMH FLEXONIFLEX Expansion Joints. 1500 psi is a nominal pressure. FLEXONIFLEX units have been and will be designed and manufactured for much greater pressures. The revolutionary design of these units—bellows-type pressure carriers formed within integral control rings and end sections—now makes it possible to utilize the expansion joint's advantages of compactness and simplicity of installation at pressures far beyond those which had previously been considered safe.

Standard FLEXONIFLEX units have stainless steel pressure carriers, single or multiple ply, lined or unlined. Sizes range from 5/8" through 6" I.D. although larger sizes can be furnished. Suitable for temperatures from sub-zero to 1400°F. (higher with special materials).

For specific recommendations send complete details of your application.

Flexon identifies CMH products that have served industry for over 48 years.

CHICAGO METAL HOSE Corporation

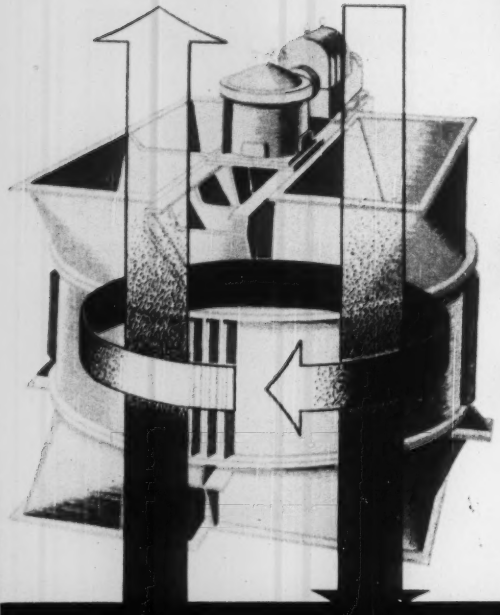
1305 S. Third Avenue • Maywood, Illinois • Plants at Maywood, Elgin and Rock Falls, Ill.
In Canada: Canadian Metal Hose Co., Ltd., Brampton, Ont.

CMH

ONE DEPENDABLE SOURCE

for every flexible metal hose requirement

Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals • Expansion Joints for Piping Systems Stainless Steel and Brass Bellows • Flexible Metal Conduit and Armor • Assemblies of These Components



this preheater is cutting fuel costs in hundreds of plants

the *Ljungstrom* AIR PREHEATER

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.

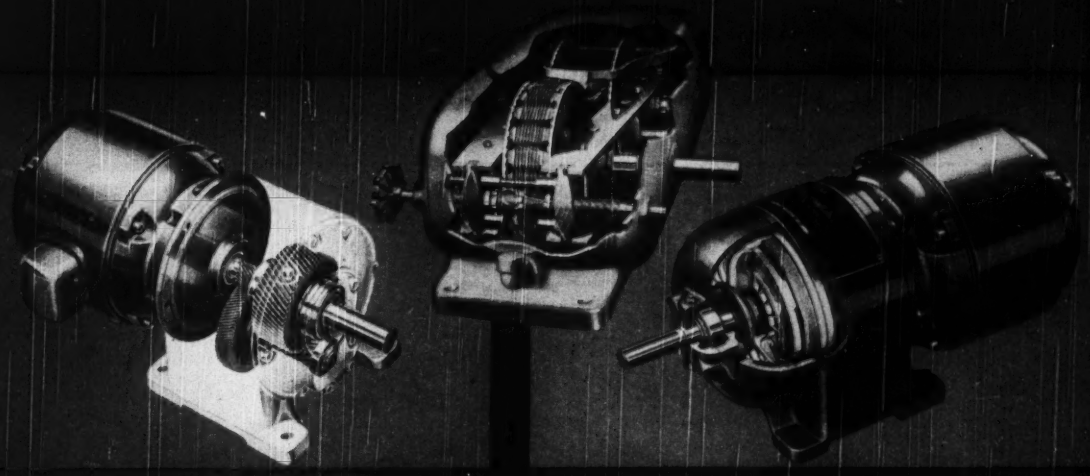
The Ljungstrom air preheater has proved its value in industrial and utility plants throughout the country. That is why every year a constantly increasing percentage of the installed boiler capacity is equipped with Ljungstrom air preheaters.

Your fuel costs will be lower too, when your boiler is equipped with the Ljungstrom air preheater. The regenerative design of the Ljungstrom permits reliable operation at low exit gas temperatures. This assures the greatest possible heat recovery . . . reduces the amount of fuel required.

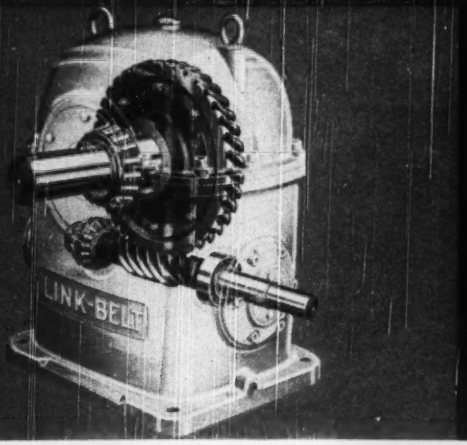
If you are planning a new installation, or expanding your present one, our engineers will welcome the opportunity to show you how the Ljungstrom can raise the overall efficiency of *your* plant.

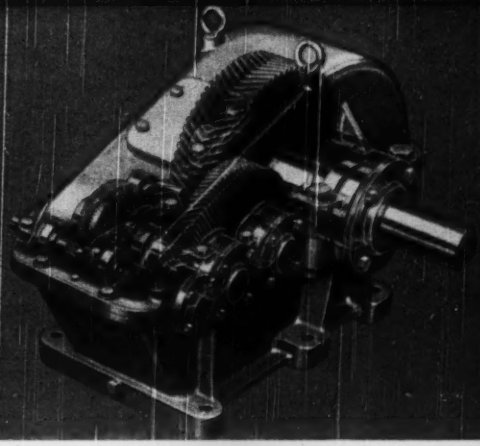
THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.



A Right Drive For Any Problem





Consult Link-Belt!

Power at the required speed is available through the use of a Link-Belt enclosed gear drive. Regardless of your specific needs for ratio, power or speed, we have the correct answer, and our engineers will be pleased to assist you with your power transmission problems.

Gearmotors

Packaged Power Drives that are compact, economical and highly efficient are available with ratings from 1 to 30 horsepower and output speeds from 280 to 6 R.P.M. These easily-installed streamlined Gearmotors are completely explained in Book No. 1815-A, a copy of which is yours for the asking.

PIV Variable Speed Drives

In any process where precise speed is a factor in quality, costs, efficiency or profits, the PIV Drive is the ideal answer to your problem. Built with vertical or horizontal housing, plain or motorized, and with or without enclosed reduction gears. From ½ to 25 h.p. and ratios up to 6:1. Send for Book No. 1874-B.

Worm Gear Drives

For high reduction drive arrangements, these time-proved rugged drives are an ideal answer. Take your choice from a complete line of single, double or helical Worm Gear Drives having horizontal or vertical output shafts and satisfy exactly your requirements. We would be pleased to send Book No. 1824, which describes in detail our Worm Gear Drives.

Herringbone Gear Drives

Link-Belt's large selection of single, double and triple reduction Herringbone Gear Drives adequately fill the bill for small, moderate or large horsepower speed reduction requirements. A mighty good answer to your speed reduction problem. May we send Book No. 1819 so you can see for yourself?

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices, Factory Branch Stores and Distributors in Principal Cities.

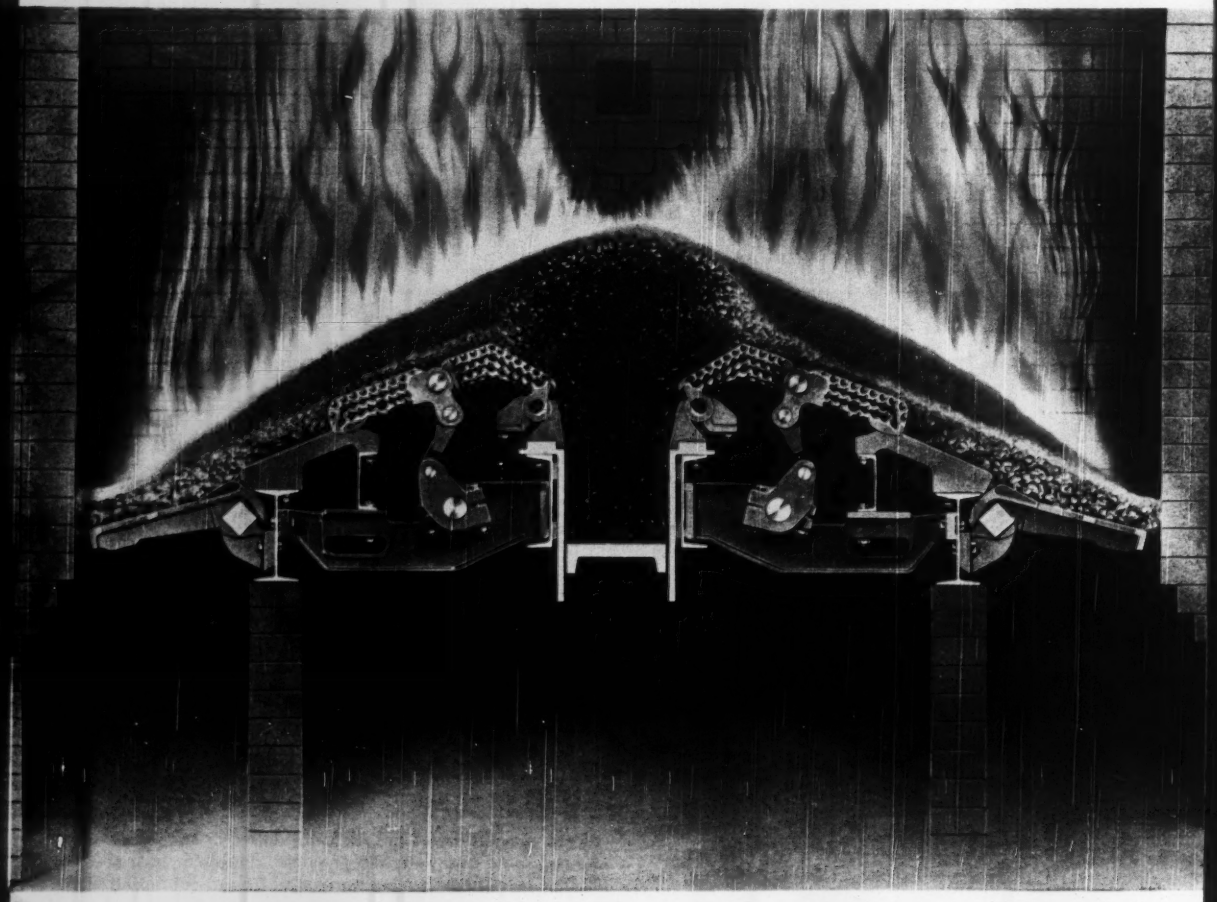
11,807

LINK-BELT

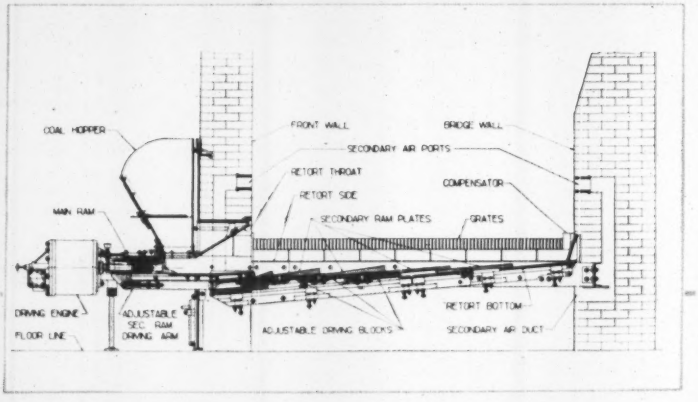
Enclosed Gear Drives

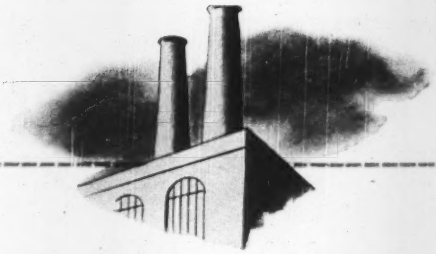
YOU CAN BE **SURE**.. IF IT'S

Westinghouse



A cross-section view of the fuel bed of the Link-Grate single-retort stoker is illustrated above. This stoker brings advantages, favorably comparable to those of the larger-capacity multiple-retort Link-Grate stoker, to the average-sized power plant (base-load capacities up to approximately 30,000 lbs. steam per hr.). It is readily installed under existing boilers with a minimum of excavation or furnace changes.





Where there's NO smoke there's a BETTER fire

The axiom, "Where there's smoke there's fire" should not apply to today's power plant.

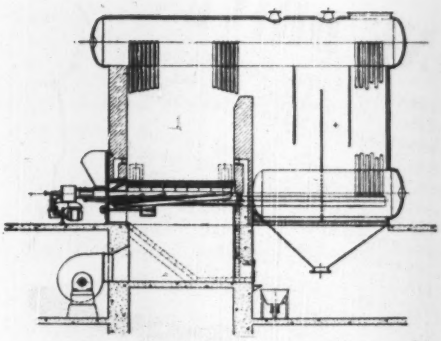
Look for the clear stack of a properly operated Link-Grate stoker-fired boiler. Combustion is thorough. No belching of smoke.

WHY—The Link-Grate's wave-like motion keeps the fuel bed porous—assures intimate mixture of fuel and air. The Link-Grate's motion maintains continuous movement of fuel bed toward the dump grates—fuel and air flow are uniform.

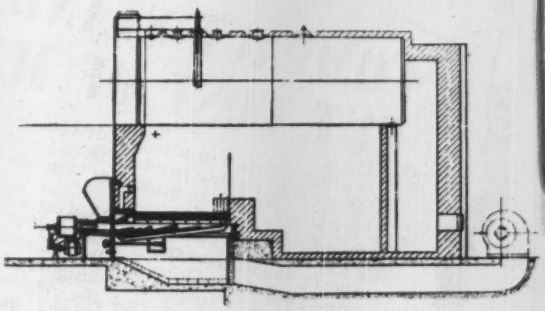
RESULT—*High Efficiency*.. by thoroughly burning the fuel on the grates with negligible waste up the stack.

Happy Neighbors..The Link-Grate stoker-fired plant is the pride and joy of the smoke inspector.

Before you buy any stoker, be sure you know the facts about the Link-Grate. Preferably, see one in operation. Your nearest Westinghouse Office will be glad to arrange an appointment with a user. Ask or write for Booklet B-2196-A. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50506



Installation for 32,000 pounds of steam per hr.

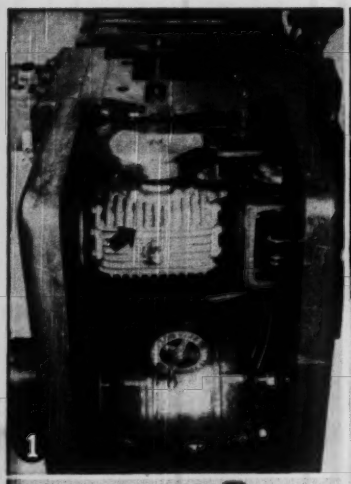


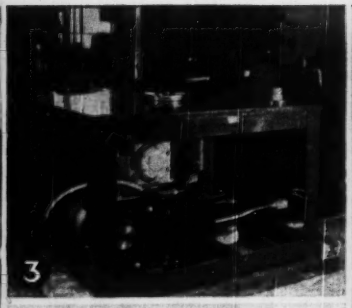
Installation for 10,000 pounds of steam per hr.

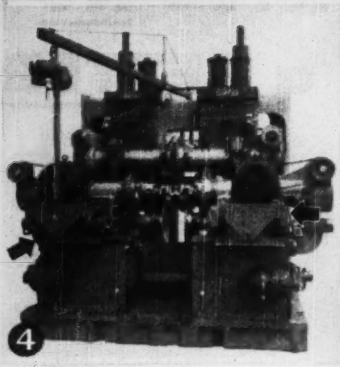
Westinghouse

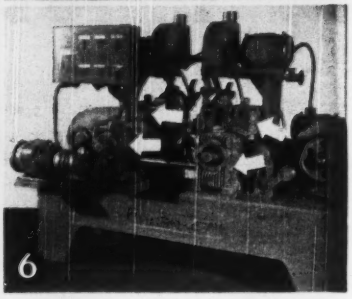
Link-Grate

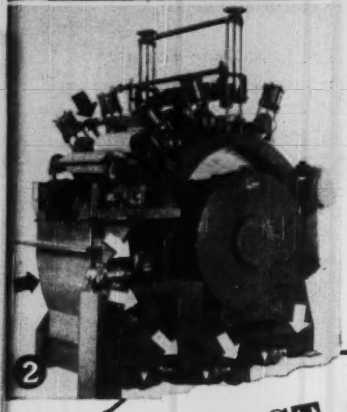
STOKERS











1. *PROGRESSIVE flash welder*
2. *OLIVER board former*
3. *HANCOCK power bender*
4. *GISHOLT crankshaft miller*
5. *JENSEN dairy churn*
6. *NASH double end automatic wood facing machine*

COMPACT STANDARD REDUCERS CUT COST OF MACHINE DRIVES

Latest wrinkle in machine design and construction is to use standard stock Cone-Drive Gears reducers instead of "built-in" gearing.

Made possible by the high load carrying capacity and extreme compactness of double enveloping Cone-Drive gearing, the idea does away with special gear designing and bearing calculations, plus the necessary machining of castings, assembling of gears, shafts, bearings, etc.

The variety of machines on which the standard stocked Cone-Drive Gears reducers have simplified and reduced the cost of machine drives is indicated by the examples shown here.

Where, for some reason, use of completely assembled "ready-to-install" speed reducers is not feasible, machine designers in increasing number are specifying STANDARD Cone-Drive Gears, complete with STANDARD MOUNTINGS.

Either way, Cone-Drive Gears give you a lower cost per horsepower.

It will cost you nothing to find out how much easier and less costly you can make your machine drives. How about doing it today?

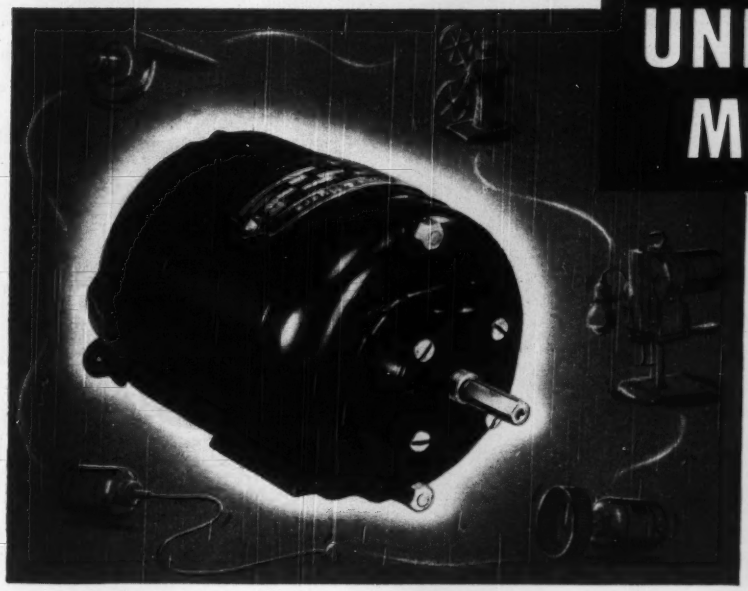
CONE-DRIVE GEARS

CONE-DRIVE GEARS *Division, Michigan Tool Company*

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

7171 E. McNichols Road • Detroit 12, U.S.A.

YOU'LL LIKE THESE R & M UNIVERSAL MOTORS



They Help You Solve Your Problems!

High starting torque; high operating speed; adaptability to speed control—to *these* inherent characteristics of series motors Robbins & Myers has added *many performance advantages.* New, completely redesigned R & M universal motors, from 1/100 to 1/3 horsepower, are ready *now* for powering your small equipment.

BETTER, INSIDE AND OUT

From their *dynamically balanced* armatures to their rigid, welded-steel shells, nothing has been slighted. Commutation, brushes, bearings, insulation, and ventilation all represent *true progress*—progress backed by the competence born of long, successful experience.

STANDARD TYPES—AND "SPECIALS," TOO

In the four frame sizes, there's the *right motor* for every need—sleeve or ball-bearing; fixed rotation or reversible; open or totally enclosed; standard or special ratings . . . and a *welcome variety* of housing types and end-heads.

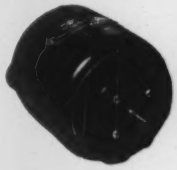
YOURS FOR THE ASKING

We'll be glad to send you literature on these new motors. And, if you would like to have R & M sit in on a discussion of *powering improvements*—that's yours for the asking, too. Address Robbins & Myers, Inc., Motor Div., Dept. F-50, Springfield 99, Ohio.

STANDARD PAD BASE

STANDARD LOW BASE
(Also "Medium" and "High" Types)

HUB MOUNTING



FACE MOUNTING

FLANGE MOUNTING

FOR MODERN, COMPACT PRODUCT STYLING—USE

MOTORS by ROBBINS & MYERS

COCHRANE DEAERATOR

500,000 lbs/hr at LONGVIEW FIBRE CO.

AT LONGVIEW Fibre Company's new high pressure steam and electric plant at Longview, Washington, feedwater for the two 900 lb. boilers is deaerated by the Cochrane Deaerator shown here of 500,000 lbs/hr capacity, operating at 20 p.s.i. steam pressure.

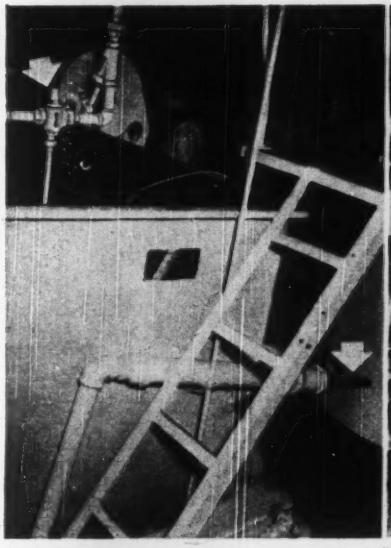
The Longview installation is an interesting one in many respects, both 900 lb. boilers being located outdoors, a practice well-established in the southern Pacific Coast area but not so common as far north as Longview.

The Cochrane Deaerator selected for this important steam plant is additional evidence of the demonstrated performance of Cochrane equipment, not only in the pulp and paper industry, but in steam plants in practically every industry. For information on all phases of the deaeration of water write Cochrane Corporation, 3142 N. 17th St., Philadelphia 32, Pa. In Canada: Canadian General Electric Company, Ltd., Toronto.

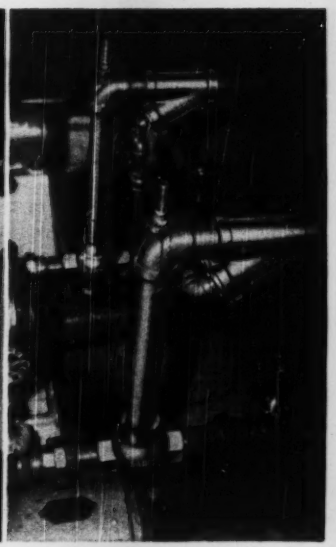
COCHRANE CORPORATION 87 YEARS OF SERVICE 1863-1950

COCHRANE CORPORATION • PHILADELPHIA 32, PA.

THE COST OF COLD



Sarco TR-21 on can cooling



Sarco Blenders on Diesel engines

It's human to play safe and "open her up wide" when cooling is done by hand control. But what is the cost of too much cold and more cooling water than you need?

In Process Cooling

The cooling hook up above handles forty No. 10 tins of syrups or foods per minute. It's a conveyor job with temperatures critical above sixty degrees. Formerly wide open, for safety, Sarco now opens or closes the valves down to a trickle as needed. Production is uninterrupted and absolutely uniform. Catalog No. 700.

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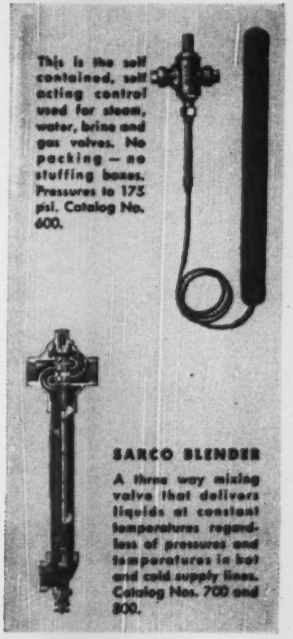
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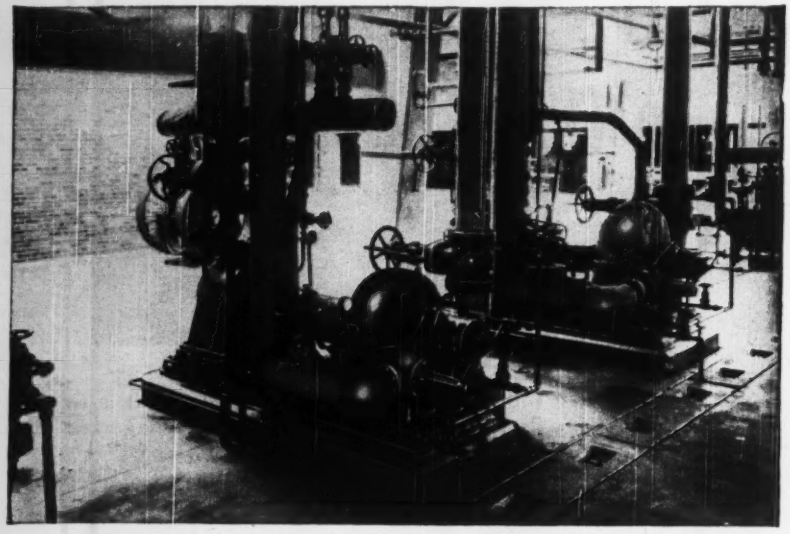

THE ROTORS OF THESE 75 H. P. TERRY TURBINES ARE DOUBLE RIM PROTECTED

The two 75 H.P. Terry Turbines shown above (in the plant of a leading refiner) employ the Terry Solid Wheel Rotor. The wheel is made from a single steel forging and the buckets are milled directly into the wheel. — All as shown in the illustration at the left.

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This feature and many others of the Terry Wheel Turbine are fully discussed in our Bulletin S-116.

T-1169

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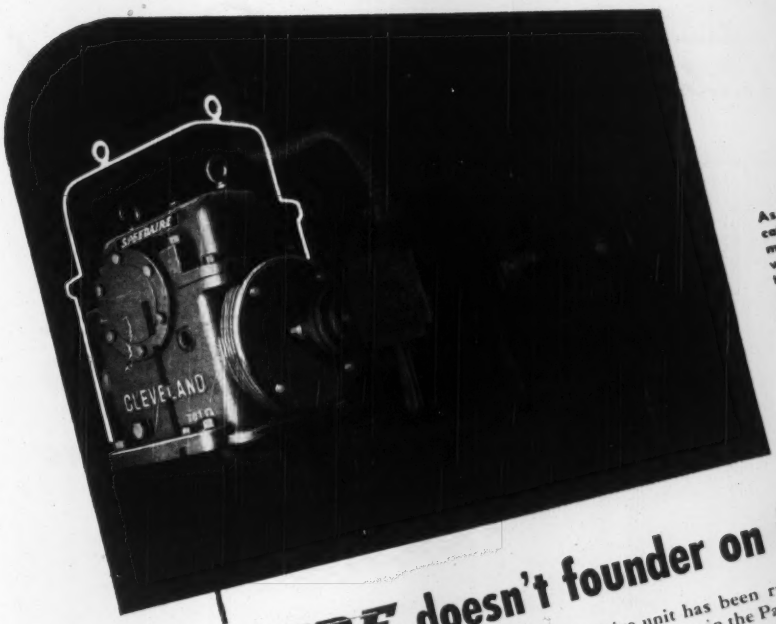
TERRY SQUARE, HARTFORD, CONN.



As the white outline indicates, a standard unit of much greater frame size would be required to do the work of Speedaire.

Photograph by courtesy of the Packard Motor Car Company.

SPEEDAIRE doesn't founder on foundry sand

FOR well over a year, this Speedaire unit has been running continually, driving a spiral conveyor in the Packard Production Foundry at Detroit. As the photograph reveals, operating conditions are quite severe, both motor and reducer being subjected constantly to sand and grit.

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Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers, Limited.

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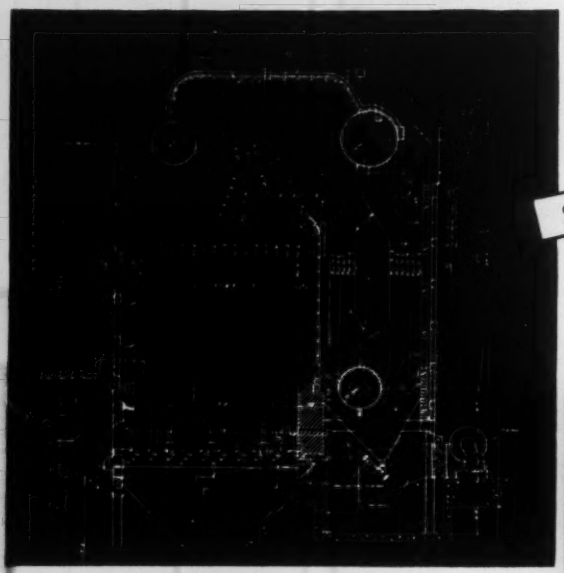

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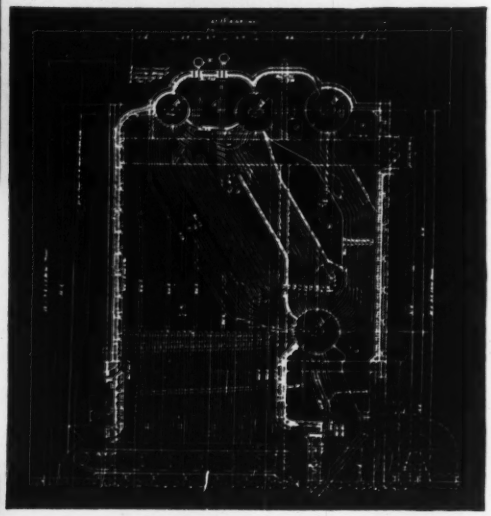
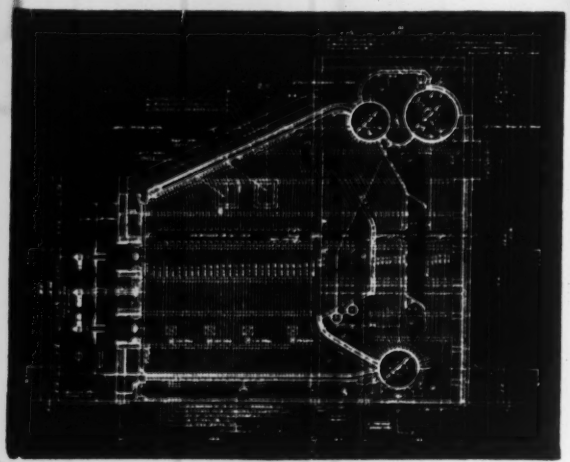


CLASS VL Two 27,500 pounds per hour units, installed at Brown-Forman Distillers Corporation, Louisville, Ky. Features large furnace volume in limited space, with high ratio of radiant heating surface.

CLASS LE Mt. Carmel Public Utility, Mt. Carmel, Illinois, is served by this 60,000 pounds per hour unit. Generous steam liberating surfaces and steam space permit wide fluctuations in load.

CLASS VR 70,000 pounds per hour steam generator at Humble Oil and Refining Company, Johnsue, Texas. An efficient, high-duty unit with water cooled furnace, using refinery gas fuel.



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R-S valvEvents

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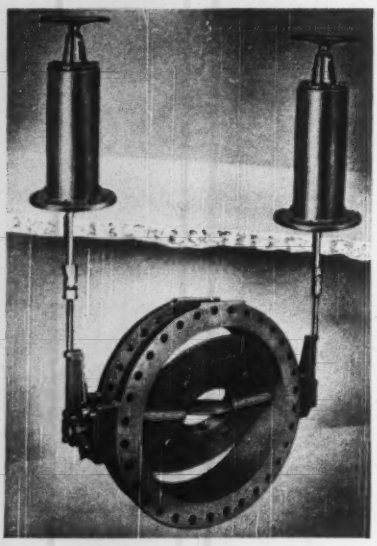

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36 inch x 8 inch heavy duty dual valve with 125-pound Am. Std. flanges controls maximum flow with a small pressure drop in large 36-inch valve. By closing large valve, small inner 8-inch valve controls small flow with high pressure drop. Separate handwheel controls for each valve vane patented. Automatic control and drip tight rubber seat available.

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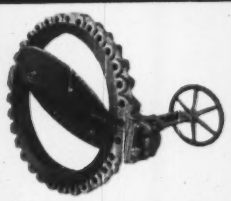
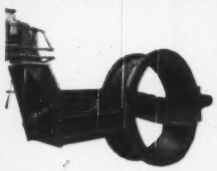
No. 680—Standard heavy duty valve with handwheel control—self-locking worm and gear. Automatic control and rubber seat available with 125-pound flanges. Rubber seated valves are drip tight with water at 100 psig and air bubble tight at 80 psig under temperatures up to plus 275° F. and as low as minus 40° F.



No. 771—Heavy duty water type valve equipped with handwheel control—self-locking worm and gear. One-piece body casting. Vane, shaft assembly and handwheel control identical with double flanged valve. Face-to-face dimension does not reduce torque. Flareout on body casting accommodates large mounting bracket base same as No. 680.



No. 734—72 inch 125 pound "H" metal valve for 800° F. Equipped with cooling fins, oil cylinder and positioner utilizing 200 psig operating oil pressure and 0-15 psig instrument air. Positioner cam driven simulating straight-line semi-log control curve or other characteristics if desired.

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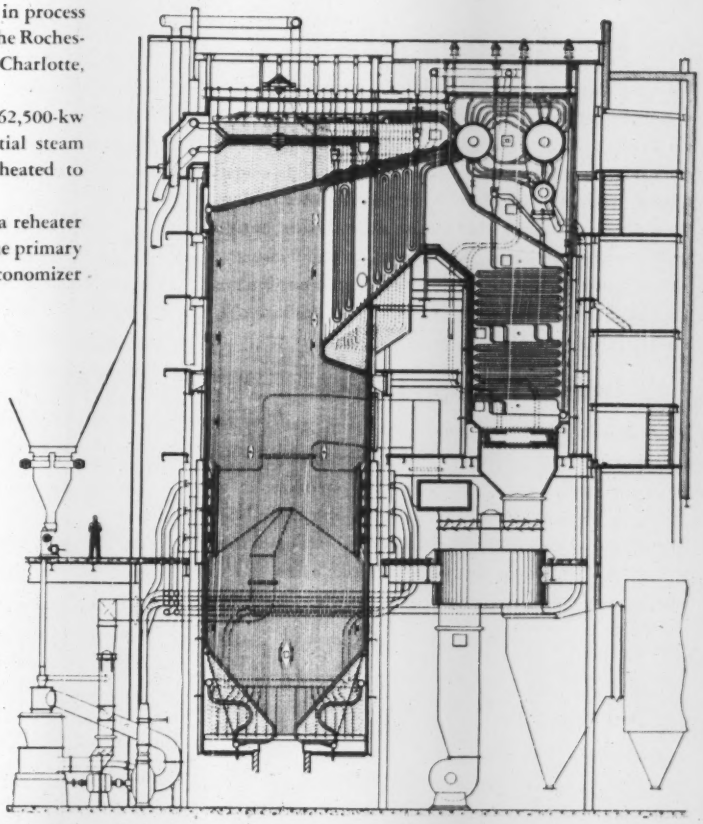
Pulverized coal firing is employed, using bowl mills and vertically-adjustable, tangential burners. B-386



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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 72 NUMBER 5

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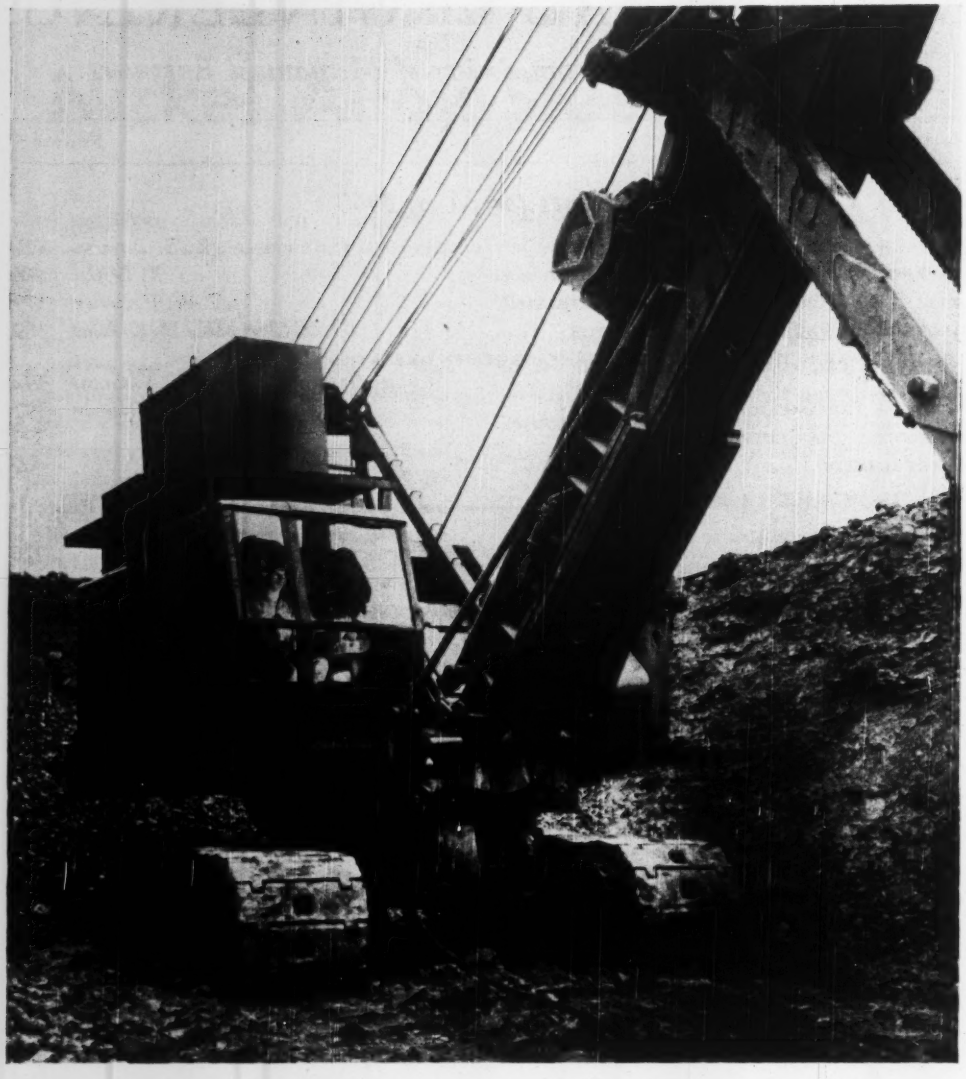

Giant Shovel With Air-Cooled Cab

(Operator of this giant electrically powered crawler-type shovel handling hot slag from a Pittsburgh steel mill is protected from excessive heat and fumes by an air-conditioning unit mounted atop the cab. The cab-cooling equipment, a development of Dravo Corporation, supplies the cab with 400 cu ft of conditioned air per minute, holding inside temperature at approximately 80 deg. The shovel operates in two parallel trenches 600 ft long into which 2800 deg molten slag is poured.)

VOLUME 72
No. 5

MECHANICAL ENGINEERING

MAY
1950

GEORGE A. STETSON, *Editor*

Understanding Engineering

IN the 1946 Terry Lecture at Yale University, the distinguished president of Harvard, James B. Conant, focused attention on an historical approach to the understanding of science. It was his contention that "science can best be understood by laymen through a close study of a few relatively simple case histories," that "each case history should be studied only to the extent that it illustrates principles of the Tactics and Strategy of Science," and that "there is a real danger that in any consideration of historical material one may overemphasize the role of a few brilliant generalizations which from time to time in the last three hundred years have played so important a part in the advancement of science."

Dr. Conant stated that his purpose "in leading a class through a group of closely related case histories would be to illustrate the following points which have wide applicability: (1) The influence of new techniques of experimentation and their connection with the practical arts. . . . . (2) The evolution of new concepts from experiment. . . . . (3) The difficulty of experimentation and the significance of the controlled experiment. . . . . (4) The development of science as an organized social activity. . . . ."

Using the air pump as an example, Dr. Conant deftly illustrated the manner in which his four points can be forced into the consciousness of students. Starting with Agricola's observation (1556) of the 34-foot suction limitation in the pumping of water, and Galileo's erroneous explanation of that phenomenon (1638), he traced developments by Torricelli and Viviani in Italy (1643), Pascal and Perier in France (1647–1648), and Otto von Guericke in Germany, to those by Robert Boyle in England (1660). In an era when Boyle's law can be glibly recited by every school child and constitutes the starting point of a vast number of scientific developments, new and old, the long and faltering progress made three centuries ago is viewed in sharp contrast. But fundamental and useful as Boyle's law turned out to be, it was not the sole fruit of those years of thought and experimentation. For as Dr. Conant points out there developed simultaneously the tactics and strategy of science which are today an even greater heritage than the familiar "law" itself.

On this evolutionary process we ponder too infrequently, forgetting that it continues at even a more rapid rate today than in the seventeenth century. And before we smile too condescendingly at Galileo's erroneous analogy between a column of water and a copper wire which might break in tension because of its own weight, we should humbly admit that many of our own explanations of natural phenomena may someday appear just as absurd to a future generation.

After three hundred years the air pump is still undergoing further developments. The number and the importance of its applications continues to grow. Collateral refinements in measurement and in producing and maintaining high vacuums and high pressures, continue amply to illustrate the purposes Dr. Conant had in mind, already quoted, in leading classes through closely related case histories toward an understanding of science. Although his principal concern was "to examine the question of how we can in our colleges give a better understanding of science to those of our graduates who are to be lawyers, writers, teachers, politicians, public servants, and businessmen," there are many who feel that his suggested approach would be amply rewarding and revealing to scientists and engineers also. For in such vast fields of knowledge as these names cover, the individual scientist and engineer is himself to all intent a layman in all but a few branches to which he has given long years of special study. And even in his own special field an understanding of the handicaps under which men of former generations worked, and an insight into the thought processes through which some new fragment was added to our total knowledge, adds luster to the achievements and to the mountain of our debt to them. It also should deepen our humility, fortify our self-confidence, and strengthen our resolution to carry forward the work begun so many years ago.

With this brief outline of Dr. Conant's proposed method of aiding laymen to understand science through close study of related case histories, we are in a better position to appreciate the beautiful example of this technique which is presented by R. E. Peterson in the ASTM paper "Nature of Fatigue of Metals" that appears in this issue. Mr. Peterson's review also covers a century of development, in this case in the understanding of an important engineering question which still engages the attention of a considerable number of our best metallurgists and engineers. When Mr. Peterson prepared this paper, he did not have Dr. Conant's Terry lecture in mind. He did, however, demonstrate independently, and perhaps unconsciously, how the four purposes which Dr. Conant had in mind could be attained in a study of fatigue.

Instead of starting with Agricola's observation on the maximum suction head, Mr. Peterson starts with a century-old paper on railway axles presented to The Institu-

tion of Mechanical Engineers in 1849. In that paper the author stated that "these axles are subject to a rapid deterioration, owing to the vibration and jar which operates with increased severity, on account of their peculiar form." With the problem thus stated, Mr. Peterson carries subsequent developments down through a century of analysis and experimentation to the present, and suggests additional fruitful areas of investigation for the future.

Ample and complete explanations do not necessarily follow a simply stated problem. One gathers that Mr McConnell, author of the 1849 IME paper, underestimated the difficulties ahead of students of metal fatigue when he expressed his belief that "the change from the fibrous to the crystalline character (of the iron) is dependent on a variety of circumstances" which he proposed to examine in "a few specimens of fractured axles from different points," and when he stated "the desirableness of maintaining . . . (journals of axles) as free as possible from sharp abrupt corners, and sudden alterations in diameter or sectional strength." A hundred years of study finds engineers and metallurgists still investigating the fatigue of metals and structures still failing in fatigue.

The temptation is great to analyze Mr. Peterson's article on the basis of the four purposes Dr. Conant announced as forming the basis of a layman's understanding of science. "The influence of new techniques of experimentation" is illustrated, for example, by Mr. Peterson's references to Mr. Slate's fatigue testing machine of a century ago, the microscope, x-ray defraction methods, and the electron microscope. "The evolution of new concepts from experiment" is found in "slipbands," "creep-rupture phenomena," "the endurance limit," and the like. No need exists to show how "the difficulties of experimentation and the significance of the controlled experiment" are revealed by Mr. Peterson, for is not his hundred-year review evidence in itself of the influence of these very factors? And, of course, the development of science as an organized social activity is implicit in the circumstances which led Stephenson and his associates to organize The Institution of Mechanical Engineers and in that famous engineer's effort, in 1849, to remind his fellow members that "the breaking of an axle has on one occasion rendered it questionable whether or not the engineer and superintendent would have a verdict of manslaughter returned against them," and to caution "members of the Institution, connected as you are with the manufacture of iron, to pause before you arrive at the conclusion that iron is a substance liable to a crystalline or to a molecular change from vibration." No "organized social activity" can lightly accept unproved hypotheses of the fatigue of metals, a subject admittedly vital to public safety, to the design of structures, and to the industrial economy.

Whether it is Robert Boyle, working on the air pump in 1660, or H. J. Gough and others working on fatigue of metals in 1950, each scientist and engineer picks up the fabric of knowledge on which others labored in the past and unborn generations will continue to further completion. The pattern of truth which is slowly woven into that fabric none lives to view in its entirety. As the threads of each man's work shoot daily through the warp of time, few can tell to what extent they clarify the pattern; yet each may hope that they go to make up the solid substance of the whole. Occasionally we may look back and try to sense the forming design, but we can only guess how it will develop later. Hardest of all is to recognize the beginnings of new elements or variations of the pattern, some of which may ultimately be found to have dominant significance. Understanding will not come from close scrutiny of individual threads or contemplation of startling but possibly subordinate motifs which are only embellishments of a larger design. To view as broadly as possible what has gone before is the one way by which the layman, at least, is permitted an opportunity of understanding.

It is too much to hope that busy engineers, each a layman except in some limited area, can find the time or the inclination to take the extensive view of science and engineering on which an understanding of their ultimate significance is based. But occasionally we have such an opportunity in a case history like the one Mr. Peterson has laid before us. Seeing this through the instruments of vision which Dr. Conant has provided is an aid to understanding. Teachers of engineering students would do well to study Mr. Peterson's paper and Dr. Conant's method. By using the subject matter of their own courses as related case histories of the development of the tactics and strategy of science and as an interpretation of the history of important developments, they can greatly enrich their educational methods and open the doors of understanding of science and engineering to their students.

Not Enough Engineering Graduates?

PERSONS who have one eye cocked on employment opportunities for engineering graduates and the other on the registration statistics of the engineering colleges report from time to time on the ebb and flow of supply and demand. This is a useful service, and the statistics are a source of interest to the profession, to the schools, and to young men and their advisers. In a brief note on page 416 of this issue, the conclusion of a subcommittee of the Manpower Committee of the American Society for Engineering Education that there will soon be fewer graduates available than are needed is reported. Yet only recently a surplus was expected.

How seriously the decisions of young people and their advisers are influenced in the choice of a career by predictions of shortage or surplus of engineering graduates is not known. It is hard to believe that a capable young man of unquestioned talents who has set his heart on an engineering education will alter his decision on the basis of short-term statistical trends. For the engineering colleges the decision is not so easy to take. The decision of the colleges involves many factors which include buildings, equipment, and personnel, all of which are expensive and take time to procure, yet all must be used with a relatively high load factor, in times of surplus or shortage alike, for economical administration.

NATURE *of* FATIGUE *of* METALS

Discussions of a Century Ago and Review of Some of the Subsequent Researches[1]

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DISCUSSIONS OF FATIGUE IN 1849

ONE hundred years ago, October 24, 1849, to be exact, we find fatigue of metals being discussed in a meeting at Birmingham, England, of The Institution of Mechanical Engineers, which, incidentally, had been in existence but two years at that time.[2]

The distinguished Robert Stephenson, second[4] President of the Institution, occupies the chair; a paper "On Railway Axles"[2] is being read by Mr. James E. McConnell, Locomotive Superintendent of the London and North Western Railway:

". . . our experience would seem to prove that, even with the greatest care in manufacturing, these axles are subject to a rapid deterioration, owing to the vibration and jar which operates with increased severity, on account of their peculiar form. So certain and regular is the fracture at the corner of the crank from this cause, that we can almost predict in some classes of engines the number of miles that can be run before signs of fracture are visible.

"The question of deterioration of axles arising from various causes, which I have enumerated, is a very important one to all railway companies; that some change in the nature of the iron does take place is a well-established fact, and the investigation of this is most deserving of careful attention.

"I believe it will be found that the change from the fibrous to the crystalline character is dependent upon a variety of circumstances. I have collected a few specimens of fractured axles from different points, which clearly establish the view I have stated. It is impossible to embrace in the present paper an exposition of all the facts on this branch of the subject; but so valuable is a clear understanding of the nature of the deterioration of axles, that I am now registering each axle as it goes from the workshops, and will endeavor to have such returns of their performances and appearances at different periods as will enable me to judge respecting their treatment. When it is considered that on the railways of Great Britain there are about 200,000 axles employed, the advantage of having the best proportions, the best qualities, and the best treatment for such an important and vital element of the rolling stock must be universally acknowledged."

Mr. McConnell tells of some experiments he has made:

"In the second experiment . . . . . an axle . . . . . on being bent alternately backwards and forwards (the power being always applied on the same wheel at opposite points) was broken at the twelfth time of bending . . . . . "

He also offers advice which if heeded could have prevented many a failure since his time:

" . . . . . all my experience has proved the desirableness of maintaining . . . (journals of axles) as free as possible from sharp abrupt corners, and sudden alterations in diameter or sectional strength."

The discussion is lively and centers largely about whether or not the structure of a material changes when subjected to vibration. There is considerable difference of opinion among the discussers.

The Chairman, Robert Stephenson, comments:

"Mr. McConnell has expressed a strong opinion, that a change takes place from a fibrous structure in iron to a crystalline one during the time of its being in use. It will be satisfactory if an instance can be pointed out where this change has occurred. I have not been able to satisfy myself from many experiments that any such molecular change takes place. . . ."[5]

Mr. Archibald Slate, Birmingham Patent Tube Works,[6] is interested in the performance of pump rods, and describes what may be considered a fatigue-testing machine. (Unfortunately he did not break any test pieces, since his tests were evidently at a stress level far under the endurance limit.) He states:

"A short time ago . . . . . I made a machine in which I put an inch square bar subjected to a constant strain of 5 tons and an additional varying strain of 2½ tons, alternately raised and lowered by an eccentric 80 or 90 times a minute. This motion was continued for so long a time that I consider it equal to the effect of 90 years' railway working, but no change whatever was perceptible. I am therefore one of those who does not believe in a change from a fibrous to a crystalline structure in iron. . . . . "

Mr. John Ramsbottom, Chief Engineer of the London and North Western Railway, believes that a change takes place and comments:

"A parallel case might be observed with reference to an ash stick which if doubled will break with a fibrous fracture; but if subjected to vibration, however slight, running through it a great number of times, it will break in a different mode."

The Chairman, Robert Stephenson, intervenes for the second of three times, to offer sound advice:

"I am only desirous to put the members on their guard

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[1] Introductory paper of Fatigue of Metals Session at Pacific Coast Meeting of American Society for Testing Materials, October 10, 1949. Paper and discussion are printed in ASTM Bulletin, February, 1950.

[2] The original members were seventy in number; one of the requirements of membership was that of being "managing head of an establishment where engines or machines are made or employed." There was, however, a provision that other eminent mechanical engineers might also be admitted (1).[3]

[3] Numbers in parentheses refer to the Bibliography at the end of the paper.

[4] George Stephenson, the "Father of Railways," was the first President.

[5] Further discussion of Robert Stephenson occupies two pages of the IME Proceedings, reference (2), pp. 22–25. (IME discussions are recorded in third person.)

[6] Archibald Slate was also first Secretary of the IME.

against being satisfied with less than incontestable evidence as to a molecular change in iron, for the subject is one of serious importance, and the breaking of an axle has on one occasion rendered it questionable whether or not the engineer and superintendent would have a verdict of manslaughter returned against them. The investigation hence requires the greatest caution; and in the present case there is not evidence to show that the axle was fibrous beforehand, but crystalline when it broke. I therefore wish the members of the Institution, connected as you are with the manufacture of iron, to pause before you arrive at the conclusion that iron is a substance liable to crystalline or to a molecular change from vibration. . . ."

This is followed by Mr. McConnell's furnishing what he believes to be "nearly incontestable evidence of the truth of my position." After much more discussion, the meeting ends, leaving the question far from settled. So much, then, for our looking-in at this meeting one hundred years ago.

The discussion along the foregoing lines continued throughout 1850, in the meetings of January 23, April 24, and October 23. (The Institution held four meetings annually at that time.) It is not worth while to go into detail concerning these discussions; only two discussions will be noted, one humorous and the other technically significant.

Mr. P. R. Jackson suggested that a vote of those present be taken as to opinion regarding whether a material remains fibrous or becomes crystalline under vibration. The Chairman, however, was equal to the occasion and replied that such a vote would be contrary to the practice of the Institution.

Mr. P. R. Hodge remarked (3) that to arrive at any true results as to the structure of iron, it would be necessary to call in the aid of the microscope, to examine the fibrous and crystalline structure.

This excellent suggestion, which seems so obvious to us now, was pursued by Robert Stephenson who reported (4) that he had since the last meeting examined "a piece of iron called crystalline, and a piece of iron called fibrous" under a powerful microscope and that it would probably surprise the members to know that no real difference could be perceived.

The direct effects of repeated straining were not to be observed microscopically for another half century. The statement of Robert Stephenson did not end the discussion by any means. Mr. McConnell stated that an alteration took place in the quality or condition of the iron as was manifest from a great abundance of evidence; and he thought that it would be a decided improvement if they would adopt some other word which could express the quality or condition of iron in its (brittle) state; it was clear that a change did take place, making that which was originally tough quite brittle.

One might ask at this stage why the author has devoted so much space to the early Institution of Mechanical Engineers meetings, since no conclusions or direct results seemed to have been attained. These are not even the first discussions of the subject.[7] The centennial aspect is, of course, of interest, but more important is the fact that these meetings were characterized by particularly spirited discussion which was carefully documented. It should be noted that, in the fatigue-of-metals field, the concepts which we now so readily accept as self-evident were not easily gained. The elementary facts of fatigue of metals could not be forthcoming until systematic tests were made. The tests of James and Galton had been carried out for the "Iron Commission," but the significance of these tests was not fully appreciated at the time.[8] The well-known investigations of Fairbairn (12) and Wöhler (13) were to come later.

It is of interest to note that the steam engine and its application to pumps and locomotives introduced dynamic repetitive loading of a magnitude not experienced previously in machinery and structures, with the result that fatigue failures occurred in service; this field experience led to the early work indicated in the foregoing.

The approach was therefore an engineering one, intended to answer practical questions. The first main facts might have been discovered by means of abstract investigations of the effects of cyclic loading on materials, conducted entirely along scientific lines; such a sequence was evidently not responsible for opening the field of fatigue of metals. In view of this circumstance, considerable importance should be attached to meetings where experiences are reviewed and discussions take place aimed at interpreting and understanding service behavior.

REVIEW OF SOME OF THE SUBSEQUENT RESEARCHES ON MECHANISM OF FATIGUE

The question of "crystallization," under discussion a century ago, was not completely clarified for a long time.[9] Older ideas were not easily discarded; it had been thought that *magnetism*[10] was a factor, that steady load would cause deterioration of a member with "time" (14), that "loading velocity" (15) would explain the mysterious service failures, that repeated loading induced "permanent set" (16), and so forth.

While we have mentioned, in the title of this paper and elsewhere, early discussions of "fatigue," this name was not at first used, but instead the phenomenon was more apt to be called "crystallization due to vibration" or to some other cause, such as mentioned previously. The term "fatigue" was first introduced into the literature in 1854 by Braithwaite (17), who said that the term had been suggested by Mr. Field.[11] As

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[7] See, for example, references (5, 6, 7, 8, 9, 10).

James Nasmyth, famed inventor of the steam hammer, in a lecture in 1842 (6), stated: "In locomotive engines the axle was the chief point of danger; and it was therefore important, both as a scientific and practical question, to determine the nature and habitude of iron when placed under the circumstances of a locomotive axle. Experiment was the only way to discover this, and he would have wished to place iron under exactly similar circumstances; but the short time intervening since the subject had come before the Section had rendered it impossible to do so. One opinion was, that the alternate strains in opposite directions, which the axles were exposed to, rendered the iron brittle, from the sliding of the particles over each other. To illustrate this, Mr. Nasmyth took a piece of iron wire and bent it back and forward; it broke in six bends."

The subject was not unknown in America at these early times, Professor Mapes (10), in 1844, comments: "Notwithstanding the many fashionable hypotheses in relation to the wearing out or ultimate non-cohesion of the particles of iron in railroad tracks, by weight of load and linear impingement, still it was clearly shown that by practical results, stated at these conversations, when a rail was of sufficient width and thickness, the impingement of the wheels did not deteriorate the quality."

[8] In 1847 a Commission was appointed "to inquire into the application of iron to railway structures." In this connection James and Galton made a variety of tests, including some repeated stress tests. The Commission report was published as a government document in 1849 (10a). The results were not published by James and Galton before a technical society. The main findings were, however, mentioned by Fairbairn in 1850 (11), and discussed in more detail in 1864 (12).

[9] Mr. R. L. Templin points out that considerable misunderstanding still exists regarding "crystallization." He felt that a notable educational contribution was made by the National Bureau of Standards Letter Circular LC204, "Metals Do not Crystallize Under Vibration" July 14, 1926 (Replaced by LC486—Jan. 6, 1937).

[10] "The rapid rotation of the axle produces a powerful magnetic action, while the friction causes much heat; and these effects, added to the constant percussion which is produced by the peculiar motion of railway wheels, cause crystallization to be produced with extreme rapidity; the effect being probably further increased in the axles of locomotive engines by the magnetising power of the electricity generated by the effluent steam," from paper by Charles Hood (FRAS) before The Institution of Civil Engineers (1842), reference (7).

M. Francois and Colonel Aubert in their report to the French government, concerning axle failures, attribute the crystalline appearance of fracture to "magnetic and electric changes in the molecular structure of the iron, caused by friction in the bearings and great velocities" (8.)

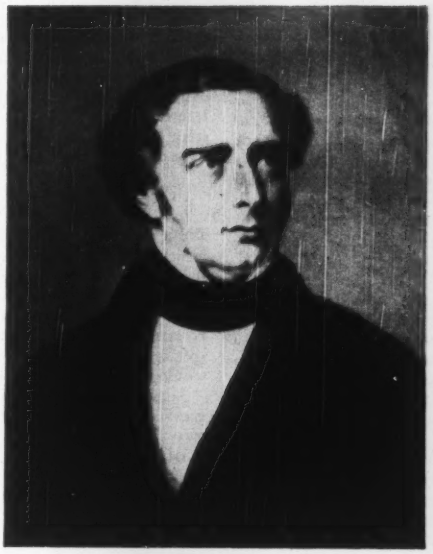
[11] Presumably Joshua Field, FRS, President of The Institution of Civil Engineers, 1849.

might be expected, this new term brought forth discussion as to its appropriateness (such discussions are still forthcoming). Braithwaite replied that he merely adopted Mr. Field's term because it was the most expressive he could find, and because the action was progressive (a reasonable answer, then and now).

The concept of an endurance limit was established by the tests of James and Galton, Fairbairn, and Wöhler; this was a necessary concept since the question is not whether vibration has an effect on metal, but what vibration amplitude is required for an effect to manifest itself. (Archibald Slate, for example, ran all of his tests under the endurance limit.)

The use of the metallurgical microscope, in studying effects of fatigue, suggested (as mentioned earlier in the paper) nearly 100 years ago, was of great importance in advancing knowledge of the mechanism of fatigue of metals. A number of excellent papers dealing with research by metallographic methods appeared in the years just before and after the turn of the century.

A milestone along this road is the work of Ewing and Rosenhain (18) in describing "slip bands," and thereby showing what happens as elastic conditions become exceeded locally. By straining the specimen after polishing and etching, it became possible to obtain observable effects.



ROBERT STEPHENSON

[Robert Stephenson, second President of The Institution of Mechanical Engineers, was chairman during the meeting mentioned in the first part of this paper and also contributed considerably to the discussion. He was sufficiently interested to personally examine metal under the microscope for evidence of "crystallization" due to service.

(Next to George Stephenson, his son Robert ranks easily as the greatest of the pioneers of the railway system. Robert was largely responsible for the design of the famous locomotive, the "Rocket." He was a member of Parliament for twelve years, was elected FRS in 1849, and was President of The Institution of Civil Engineers in 1856 and 1857 (1).)]

This was followed by the work of Ewing and Humphrey (19) wherein the behavior of a polished and etched specimen subjected to repeated stress was observed under a microscope. The connection between slip and eventual breakdown in fatigue was established by this work. Regions of heavy slip were shown on polishing and etching to have developed cracks corresponding in location to the original slip lines.

Scientific work in a new direction is not without a certain excitement, as one can sense by reading the discussion (20) between Rosenhain of England, Osmond of France, and Heyn of Germany.

Further research with the aid of the microscope was carried out by Gough and Hanson (21), who coupled precise mechanical tests (static and fatigue) with observations under high magnification. It was shown that slip lines occur under the endurance limit and, in some cases, even below the proportional limit.

Research on the fatigue of single crystals was started by Gough and his co-workers (22) in 1923, and extended over the following ten years (23). This work covered such materials as aluminum, iron, zinc, silver, antimony, and bismuth; in most cases single crystals were tested, but in a few cases groups of a few crystals were contained in a test section. These investigations were characterized by x-ray determination of the lattice orientation with respect to the axis of the test piece and an analysis of the stresses acting in the principal directions on the crystallographic planes. The specimens were subjected to repeated torsion, and the resulting slip lines and fatigue cracks were observed with a microscope. It was found that slip occurred in accordance with the maximum resolved shear stress.[12] In traversing around a single-crystal specimen subjected to torsion, the directions of maximum resolved shear stress change, and it is interesting to note how sharply the slip lines change in direction accordingly.

Slip behavior as just described is produced by static loading or by repeated loading. With repeated loading there is a tendency to slip back and forth on a particular slip plane; this usually brings forth a "contest" between two tendencies: (*a*) tendency to work-harden in the region of the slipping surfaces, (*b*) tendency for the slipping surfaces to break down into a separation or crack. Sometimes (*a*) predominates, as in the case of understressing where there is considerable slip but no failure, and sometimes (*b*) predominates, in which case the usual fatigue failure results. The conditions which determine the outcome of the "contest" are not well understood.

Orowan (26) has suggested a model wherein a plastic element in an elastic surrounding undergoes strain-hardening in decreasing amounts with numbers of cycles. As the plastic element strain-hardens, the stress acting on the element increases. If the stress reaches the failure value, a crack occurs and fatigue failure follows due to the spreading of the crack. If the plastic element does not attain the critical failure value before strain-hardening ceases, fatigue failure will not occur. Although fatigue failure is more complex than is represented by Orowan's model, yet the basic mechanism which Orowan proposes must certainly form a part of any adequate description of fatigue failure.

As we have noted, certain slip lines eventually become separations or cracks. One or more of these minute sources starts to spread, and this develops into a gross crack which, in general, meanders through the grains in a zigzag fashion in an average direction normal to the direction of tensile stresses. It should be remembered, however, that although the fractured surface generally follows a normal stress field, the microscopic source of failure is due to shear.

In design involving combined stresses, shear theories are used, either the maximum-shear theory or the shear-energy theory. With regard to the latter, there appear to be two

[12] See also previous work on single crystals subjected to static stress (24, 25).

schools of thought; one group sees real significance in energy[13] per se as a criterion of failure, while the other group (28, 29, 30) points out that, if one considers random orientation one obtains, analytically, approximately the same ratio, $1/\sqrt{3}$, of torsion yield to tension yield.

While a complete theory has as yet not been determined, at least it can be said that, for ductile materials, shear is the basic mechanism determining the start of failure. Since plasticity is also a shear phenomenon, the large amount of work in the field of plasticity undoubtedly will produce results which will be useful in the fatigue field. The theory of dislocations (31) is of interest in this connection.

X-RAY DIFFRACTION METHODS

X-ray diffraction methods have been used to determine structural changes associated with failure (32, 33, 34, 35). A breakdown of the grains into a mass of crystallites having a limiting size of 10^{-4} to 10^{-5} cm occurs whether static or repeated loading is used to produce failure. Cycling to failure results in heavy lattice distortion of the crystallites, indicating severe internal stresses in the crystallites. Later tests by Wood and his associates (36) have shown residual stresses in the lattice (not to be confused with gross residual stresses in a test piece) as a result of yielding. Further work of this kind needs to be done in close correlation with cycling tests in the region of the endurance limit.

ELECTRON MICROSCOPE

The electron microscope has been used to study the slip process in aluminum crystals (37). A "slip line" or "slip band" in aluminum was shown to be a laminar region consisting of a large number of laminae about 200 A thick and relatively displaced about 2000 A. If this technique could be used to determine the effects of cycling it seems that a better understanding would be obtained of the mechanism of the development of slip into separation or cracking.

It is of interest to examine the conditions of failure in a material where slip and work-hardening do not exist. Tests have been made of glass rods (36) in bending under three conditions; (*a*) nonrotating, (*b*) rotating 14 rpm, and (*c*) rotating 10,000 rpm. For various stress levels, the average time to fracture was found to be approximately the same.[14]

It is of course well known that steel at constant stress and high temperature will fracture with time, the time interval depending on the applied stress. This is the so called "creep-rupture" phenomenon, which has become of major importance in gas-turbine design. The same phenomenon occurs in lead at room temperature. Creep-rupture fractures, in general, are characterized by being intercrystalline, while the usual fatigue fractures are transcrystalline. Moore (39) cites a case where fatigue tests were made at 1200 F of 0.20 per cent C steel at 300 cycles per min and at 2500 cycles per min. When plotted on a "number of cycles to fracture" basis, the curves were separate, but when plotted on a "time to fracture" basis, one curve represented both sets of data. Moore cites this as a coincidence, but one cannot help but notice the similarity to the results with glass. Moore also states that in fatigue tests of lead at room temperature the "time to fracture" seems to decrease as the frequency increases.

With regard to mechanism of failure at elevated temperature, the work of Hanson and Wheeler (40) is of interest. They made microscopic examinations of aluminum specimens subjected to prolonged loading at temperatures up to 400 C. They found that at the higher temperatures, the number of slip lines increased to such an extent as to become difficult of detection. In other words, for a given deformation, an increased number of steps means smaller displacements; it was suggested that, in some cases, the slip lines may be invisible under the microscope.

RUPTURE TESTING

It is quite evident that a fruitful direction for research lies ahead in the exploration of the relationship between the fields mentioned, where these overlap or border on each other. It should be pointed out that considerable scatter is apt to occur in rupture-testing; from an examination of the work of Gurney and Pearson (38), it is quite evident that, if they had not approached the problem statistically by using a large number of specimens (72 specimens were used for each curve), the results would have been too scattered to be of any value.

Recent studies on grain-boundary effects by Boas and Hargreaves (41) have indicated that a mechanism other than slip may be operating near the boundaries during deformation. Further work in this direction may have a bearing on the mode of failure (i.e., transcrystalline or intercrystalline), discussed previously. A recent paper by Radavich (42) seems to indicate that the electron microscope may be useful in studying grain-boundary phenomena. The grain boundaries of ingot iron varied from 0.08 to over 0.4 microns in thickness. Certain brittle conditions seemed to be associated with the thicker boundaries.

SUMMARY

As implied by the title, we have been concerned in this paper with the nature of fatigue. There is of course an engineering side of fatigue of metals dealing with the accumulation of extensive and valuable data for design use. It is beyond the scope of this paper to review the achievements on the engineering side or to mention the important men responsible for the main results. There is even a large research field in fatigue of metals, apart from research on mechanism of failure, dealing with effects of varying loads, understressing, overstressing, size effect, notch effect, application of statistical theory, etc. Again these are outside the scope of the present paper.[15]

In the present paper, we have noted how the limited knowledge of the early 1800's with regard to mechanics of materials was entirely inadequate to explain the mysterious failures occurring due to the advent of steam-driven machinery. The metal presumably "crystallized," but it was not generally realized that repetition of loading was involved. We have noted how the concept of an endurance limit was established. We have also seen how the "crystallization theory" of a century ago has been proved unsound by metallographic studies. Further, we have noted outstanding work in more recent times with single crystals and groups of a few crystals. The mechanism of slip, in accordance with maximum resolved shear stress, has been mentioned. Attention has been called to the common ground of plasticity and fatigue. The use of the x-ray diffraction method has also been noted, as well as possible use of the electron microscope. Conditions of failure in glass and in lead at room temperature, and in steel at high temperature have been mentioned.

CONCLUSION

In conclusion, while we have learned a great deal about the nature of fatigue of metals in the past 100 years, it is apparent

[13] See review of recent views on energy theories (27).

[14] This is an especially striking result when one considers that the volume of material subjected to peak stress is different in the rotating and nonrotating cases, and that the time at peak stress of any given point is different in rotating and nonrotating cases. The two circumstances may offset each other; this could be clarified by special tests planned to eliminate one of the effects.

[15] Reviews of a broader nature have been published in recent years (39, 43).

that the mechanism of slip, of creep-rupture, and of fatigue-cracking afford ample opportunities for research. It is hoped that this brief paper will serve to stimulate further work in this field, and that the review and references will be helpful to those contemplating work aimed at furthering our knowledge of the mechanism of failure of materials.

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FLOWMETER RESEARCH *and the ASME*

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HISTORICAL

THE art of accurately measuring flowing fluids is one of the relatively new fields of engineering applications and hence has required considerable research and invention to bring it to its present state. While much is known about many flow-measurement fundamentals, a large amount of investigation is needed to extend the range of metering possibilities and increase the accuracy and usefulness of present methods. This article tells of the research and development work which has been done to date by the ASME.

It is impossible to separate the general story of fluid-metering research from the story of the Special Research Committee on Fluid Meters, because the greatest advances have been made since this Committee was appointed, and its members have been in the forefront of metering developments.

Soon after the founding of the ASME, interest was shown in metering by members of the Society. The first paper on flow measurement appeared in Transactions, ASME, volume 5, 1884, authored by J. C. Hoadley and entitled "A Tilting Water Meter for Purposes of Experiment." This paper, which described a new type of tilting water meter to measure hot water, stated that commercial water meters were "wholly unsuitable—being inaccurate at best conditions, wildly inaccurate at low rates of flow, and difficult to read at high rates of flow." In the discussion, it was pointed out that the meter most used at that time was the Worthington meter, a duplex piston-type of water meter and apparently the first successful type of meter used. All meters used up to this time were of the piston-displacement type, and this type of meter is undoubtedly the oldest one in use.

The first flowmeter of the inferential head type was the Venturi tube invented by Clement Herschel and reported in an ASCE paper in 1887. Between 1887 and 1916, 37 papers on flow measurement were presented at meetings of the ASME. The important papers were: "Pitot Tubes" by W. B. Gregory in 1904; "The Measurement of Air Flow into the Atmosphere Through Circular Orifices," by R. J. Durley in 1906; "The Pitot Tube as a Steam Meter," by C. F. Gebhardt in 1909; "The Electric Gas Meter," by C. C. Thomas in 1909; "The Measurement of Natural Gas," by T. R. Weymouth in 1912; "The Measurement of Air Flow Through Plate Orifices," by E. O. Hickstein in 1915; "Experiments on Water Flow Through Pipe Orifices," by Horace Judd in 1916, and "Steam-Flow Measurement," by E. G. Bailey in 1916. Most of our modern art of measurement is based on the material covered in these papers.

Of the 37 papers mentioned, 10 were presented during the period of 1915–1916, attesting to the interest in this subject. It was of such special interest to the people in steam power plants that a group got together in 1916 and formed the Fluid Meters Committee which was first named the Subcommittee on Flowmeters of the ASME Research Committee. The membership of this Committee was originally made up of the users of meters, but early in its existence the interest of the National Bureau of Standards was recognized and Dr. Edgar Buckingham became a committee member. In 1918 the Committee decided that its field of interest should be broader than that implied by the designation "flowmeters," and its title was changed to that presently used.

In 1918 the Committee had decided on its program and on increasing its membership by including some representatives from the meter-manufacturing industry. The program decided upon was the preparation of "a textbook on the theory and use of fluid meters sufficient for a standard reference." At the same time the Committee requested an appropriation to support research in college laboratories to check meter characteristics and to compare results with previously published data. In the 32 years of its life the Committee has continued to carry out the original program, and has found that it was necessary to expand it into the sponsorship of original research programs of considerable magnitude, as well as increase the scope of its publications.

It is appropriate at this point to elaborate on two things which are of interest concerning the Committee. The first of these facts can well be stated by the quotation "Great events are the shadows of great men," and for the Fluid Meters Committee this means that the dreams and ideas of R. J. S. Pigott are those which have led the Committee in most of its work. Mr. Pigott was chairman of the Committee for 30 years. All major work was started under his supervision. There is no question but that, without his inspired leadership, the results of the Committee's work would have been of much less value.

The second fact is that this Committee was the second Subcommittee set up under the Research Committee and has been active in one field, without change in interest, for a longer time than any other research committee of the Society.

PUBLICATIONS

Following up the plans as outlined in 1918, the Committee continued preparing the textbook on fluid meters which was finally published in 1924 under the title "Fluid Meters, Their Theory and Application," and labeled Part I of Fluid Meter Report. Part I has been one of ASME's "best sellers" ever since and is now in its 4th edition (1937). The 2nd (1927) and 3rd (1930) editions were quite similar to the first one, but the 4th edition was a complete rewrite to bring the material and style up to date. This report has become the standard publication on metering practice. It is the basis of many other publications and it is one of the most quoted references both in this country and abroad. The book is now being completely revised, and the 5th edition will be published within the year.

As presently set up, the book is in three sections. The first is a discussion of the types of fluid meters, including their classification and the nomenclature used with them, the second

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covers the theory and fundamentals of fluid measurements, and the third gives the physical constants and meter coefficients for use with head meters. The new edition will probably follow the same arrangement. Since Part I of the report covered fundamental description and theory only, the Committee published two other parts of the report in order to cover the field completely. Part II consisted of a complete description of physical characteristics of meters in use in 1931. The data were secured from the manufacturers. Publication was suspended after the first edition because it was found impossible to keep a report of this sort up to date, and it was decided that interested persons could secure current data directly from the meter manufacturers more economically. Part III, published in 1933, contained a discussion of the effect of installations and instructions on methods of proper installation as applied primarily to head meters. Part III is also obsolete and it is planned to revise and incorporate this material in the 5th edition of Part I. Two other publications, one published jointly by the ASME and the American Petroleum Institute, and the other by the American Gas Association, are based on research conducted under the supervision of joint subcommittees of the Fluid Meters Committee and API and the AGA. These publications, "The ASME-API Tentative Code for Installation, Proving and Operation of Positive Displacement Meters in Liquid Hydrocarbon Service" and the "Gas Measurement Report No. 2 of the Natural Gas Department of The American Gas Association" are used as the fundamental basis for many of the commercial measurements in the country.

The Fluid Meters Committee intends to continue sponsoring publications containing the most up-to-date material available on flow measurement and to attempt to keep these publications unbiased, so they will represent the best available material on the fundamentals of measuring flowing fluids.

RESEARCH CONDUCTED

Concurrently with the publication program, the Committee initiated research to increase meter range and accuracy. The first was a study of pulsating flow directed by Prof. Horace Judd at The Ohio State University in 1919 and 1920. No further work was done until 1931. During that year it was found that the American Gas Association had a committee on orifice meters which was preparing a report to be used as the standard for gas measurement with orifice meters. In September, 1931, a joint meeting was held with the AGA committee, and it was decided that the problem of gas measurement affected many more people than those represented by the AGA and that this would be a good chance for the Fluid Meters Committee to work with industry to establish a practical metering standard. For this purpose, a Joint Subcommittee of the two committees was set up. This Joint Subcommittee first analyzed available data on orifice meters and then laid out a research program to provide necessary unavailable data. Research conducted under this Subcommittee's supervision during 1932 and 1933 was analyzed by the Subcommittee in 1934 and 1935. Two reports were prepared: one by the Joint Subcommittee, giving all of the data available at that time and an analysis of the results, and the second by the AGA committee which is, at present, the standard report on which all gas measurements are based.

The report of the Joint Subcommittee was a monumental work containing 473 pages (11 × 17 in.) of data, explanation, and curves. Its conclusions were published by ASME as one of the Committee's publications. Both the ASME and AGA reports are of interest to the petroleum industry, since there are more orifice meters measuring gas operated by oil companies than by gas companies.

Early in this project, interest was indicated in the possibility of using orifices and nozzles to measure oil flow. A program to investigate this was started in 1932 at the University of Oklahoma. This work was carried out continuously for many years, and the results published by the ASME as presentations of the Committee at various times. The results have also been used in preparing the Committee's Fluid Meter Reports.

In 1934, when the work on ASME orifices was completed, the Fluid Meters Committee, at the suggestion of the ASME Power Test Code Committee, started a research on "flow nozzles." A special subcommittee set up to do this work first standardized the shape of the nozzles and then conducted a comprehensive program to determine the discharge coefficients of these nozzles. This was undertaken in laboratories all over the country, and the results were analyzed by the subcommittee. The resulting publication has become the standard for flow-nozzle use in this country. Foreign nozzle designs also were investigated and the results of the foreign tests were correlated with those made in this country.

Work done at the University of Oklahoma indicated that head-type meters had definite limitations for oil. In 1939 the problem of oil measurement was given to a special subcommittee to make a complete study of displacement-type meters for large-volume oil measurements. Work has been in progress continuously since then. At an early date co-operation was requested from the American Petroleum Institute. When API representatives were appointed to it, the name of the subcommittee was changed to the "Joint API-ASME Committee on Volumeter Research." The Joint Committee prepared a tentative API-ASME Code on the installation and testing of displacement meters, which is being used widely.

The Fluid Meters Committee is now sponsoring three major research projects. The first is a study of the effect of irregular or pulsating flow on the meter accuracy and an investigation of the efficiency of various devices for eliminating this effect. This has been in progress sporadically since 1921. The primary results of this are represented by the development of devices for determining if irregular flow is effecting a head-type of meter and some insight into methods of eliminating the effect. Five papers have been published in the Transactions of the ASME reporting on this work.

The second study, started in 1947, is to determine the discharge coefficients of sharp-edged orifices when the hole through the orifice plate is at the side of the pipe rather than at the center, and when the hole is in the shape of a segment of a circle rather than round. These orifices, which are much used for measuring fluids carrying impurities, never have been tested completely. A progress report was presented at the 1948 ASME Annual Meeting, and published in the Transactions of the ASME, October, 1949. Completion of the work is expected during this year.

A third study is being conducted under the supervision of the Joint AGA-ASME Subcommittee on Orifice Meters. Its purpose is to determine the effect of some piping arrangements introduced since the Joint Committee report of 1935 on the discharge coefficients of orifice meters. Two factors probably affecting the meter readings are (1) plug-type valves located ahead of the orifice and (2) the use of various orifice fittings to make it easier to change orifice plates and to keep the fluid from leaking out around the orifice plate. In investigating the effect of these devices, many questions raised during 14 years' use of the data from the previous report of the joint committee may be answered.

In addition to the foregoing, an investigation of measurements of small flows was proposed in 1947 which might lead to the establishment of flow-measurement standards which could be used for pilot plants and other applications where it is necessary to measure accurately relatively small rates of flow of

various fluids. This research is now dormant and the whole problem is being restudied to determine exact industry requirements.

The range of interests of the Fluid Meters Committee can well be summarized by listing its subcommittees:

1 Standardization of Meter Piping Installations
2 Measurement of Small Flows
3 Revision of Part I of Fluid Meters Report
4 Co-operation With British Standard Flow Measurement Committee
5 Research on Pulsating Flow
6 Standard Methods for Computing Flows
7 Flow Nozzle Research
8 ASME-Instrument Society of America Research Co-ordidinating Committee
9 Eccentric and Segmental Orifice Meters
10 Supplying Material for Power Test Codes
11 Joint ASME API Subcommittee on Displacement Meter Research
12 Committee on Flow Measurement at Extreme Conditions
13 Joint AGA-ASME Subcommittee on Orifice Meters

FINANCES

Research programs of the foregoing type are relatively expensive. Individual meter manufacturers or users normally cannot afford to support a complete research program on any of the problems in fluid metering. In addition to seeking the definition and solution of these broad-interest problems, the Fluid Meters Committee has attempted to act as a clearing house for the raising of funds to undertake necessary projects. This is done by soliciting the manufacturers and users of fluid meters for support of specific programs as they are planned.

The ASME, as a membership corporation, does not have available sufficient funds to carry out any research. However, they do supply the necessary co-ordinating assistance and take care of the expenses of fund raising. The system used, to date, has made it possible to carry out a great deal of research at a relatively small cost to any individual or corporation. In the past 20 years, about $60,000 has been collected to finance the researches of the Committee. In addition, at least double that amount has been contributed to the Committee's work by interested corporations, Federal bureaus, and university laboratories in the form of engineering services and equipment. Special credit should be given to The Engineering Foundation and the Technical and Research Committee of the Natural Gas Department, The American Gas Association, for their contribution.

It should be emphasized that many interested corporations and research laboratories have contributed much in addition to helping finance the work. The Committee's work would not have been possible if this were not true. As an example, the estimated cost of the research on orifice meters, taking into account all the intangible contributions, was in the neighborhood of $150,000, although the actual amount disbursed through the Society was less than $20,000.

CO-OPERATION—FUTURE PROGRAM

The Committee has attempted to maintain continuous contact with similar committees in this country, and in foreign countries has worked with the International Standards Association, now the International Organization for Standardization (ISO), and the Vereines Deutscher Ingenieure (VDI), the British Standards Association, and the Canadian Standards Association in connection with the standardization of various metering devices. The work with the British and Canadian organizations and the ISO is continuing. It is felt that this co-operation makes it possible to have international standards which are acceptable in all countries, and it is planned to continue it so that the work of the Committee will have world-wide distribution.

There are many fluid-metering problems needing further investigation: for example, improved pulsation control; fundamental hydraulic studies in measurement; sampling and conditioning of materials to be measured; small flows; and the like. The Committee has personnel who are interested in all of these and they are willing to spend time and energy in planning researches in the various fields. The projects cannot be carried out without proper financial support, and it is hoped that the money will be available when needed.

From the foregoing outline of work done by ASME on Fluid Meters Research, it is apparent that for the last 30 years this Committee has been extremely active in sponsoring both scientific and practical researches in this field and in making the results available to all; further, that both in this country and abroad the Committee's work has become accepted as the basic standard for measurement of flowing fluids. In order to keep this country abreast of others in the field of fluid measurement, it is necessary that the Committee have all possible help from other interested organizations, ASME Professional Divisions, and from interested individuals and corporations. Only by co-operation of all these will it be possible to maintain the lead which has been established in this field.

APPENDIXES

Two appendixes, contained in the original paper but omitted here because of space limitations, are available to those interested, and may be secured by purchasing mimeographed preprint No. 49—PET-11 from the ASME Order Department.

Appendix I contains a complete Bibliography (83 papers) of the publications sponsored by the Committee and its subcommittees.

Appendix II lists the names of the members of each subcommittee and a statement of the problems assigned to each subcommittee.

IT IS a commonplace to say that science and engineering become more and more a matter of team work. Within our respective graduate schools at this moment we each undoubtedly have teams made up, for instance, of an electrical engineer, a metallurgist, a biochemist, and an aeronautical engineer, working on a common problem which none of them could solve alone. Would it not be possible to develop an even greater measure of team work between the schools themselves? Steps toward this end have been made through the ASEE. I am raising the question of whether it is not time to co-ordinate our program even further—in co-operative competition.

Obviously, what I am recommending applies mostly to graduate schools and research programs. It is in them that we run the danger of needlessly duplicating each other's efforts, of wasting time and money and personnel.

Please don't get the idea that I am advocating regimentation of curricula to the point where each school is arbitrarily allotted its particular fields of concentration. Such a concept is abhorrent to us all. I am simply suggesting that we could work out a voluntary program of planned individualism—and I stress the word "voluntary"—which could insure that we use our facilities, and our faculties, and our funds to best advantage.

(Taken from an address "Planned Individualism in Engineering Education," by Livingston W. Houston, president, Rensselaer Polytechnic Institute, before the American Society of Engineering Education, Troy, N. Y., June 21, 1949, quoted from *The Journal of Engineering Education*, October, 1949.)

MARINE GAS-TURBINE RESEARCH *in* BRITAIN

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GENERAL

IN Britain all research on gas turbines falls into the following categories:

(*a*) Government research establishments and government contracts to firms.
(*b*) Research associations.
(*c*) Research carried out by private firms.

The universities also have research facilities in the various faculties, but they are necessarily limited in scale. The principal Government Departments dealing with problems of gas-turbine work are (*a*) the Ministry of Supply, (*b*), the Department of Scientific and Industrial Research, (*c*) the Ministry of Fuel and Power, and (*d*) the Admiralty. To stimulate work on gas-turbine projects an Industrial Gas Turbine Development Committee has been set up by the Ministry of Supply to keep under review the progress of gas-turbine research and development for nonaeronautical uses and to make recommendations to the appropriate ministers in the government departments concerned on the research and development work which the committee considers it desirable to initiate.

GOVERNMENT DEPARTMENTS DEALING WITH GAS-TURBINE WORK

Ministry of Supply. Briefly, this ministry controls the National Gas Turbine Establishment (NGTE) and the Royal Aircraft Establishment. The NGTE has been largely concerned with developments for aircraft gas-turbine machinery, but is installing facilities to test compressors, heat exchangers, and the like (1).[1] It is also engaged on long-term problems of general interest to all agencies working on the development of gas turbines.

Ministry of Fuel and Power. The Ministry of Fuel and Power, owing to its interest in the efficient use of fuel, coal in particular, stimulates any research which may lead to improved power production or process work by gas turbines or other means.

Department of Scientific and Industrial Research. The Department of Scientific and Industrial Research is interested in all that stimulates scientific research, particularly when the results can be applied in industry. The National Physical Laboratory, controlled by the department, is engaged on many investigations which have a direct bearing on gas-turbine development, particularly long-term creep tests of materials and fundamental work on heat exchange. The Mechanical Engineering Research Board, the laboratories of which are at present under construction, will intensify the attack on these problems. The Fuel Research Station, which also comes under the department, carries out experiments on combustion, such as the development of combustion chambers to burn pulverized coal. Research associations for various industries, including Pametrada referred to later in the paper, operate under its aegis.

Admiralty. For all marine-engineering research, whether for naval or merchant requirements, the Admiralty is the body responsible to the Government. Admiralty research is carried on in three ways as follows:

1 Directly in laboratories under its own control such as the Admiralty Engineering Laboratory. The Admiralty Material Laboratory assists by examining the deposits and test materials in furnaces with various contaminating gases. It is also setting up a marine wing at the National Gas Turbine Establishment for the purpose of testing and developing components for naval applications and for carrying out long-term endurance tests of naval gas turbines up to 10,000 shp.
2 By placing contracts with research associations.
3 By direct contracts with private firms.

Table 1, giving a list of all marine gas turbines under construction in Britain, shows that most of the important units are being constructed to Admiralty order. The Admiralty also coordinates all the separate researches which will assist in the production of gas-turbine propulsion units. This wide interest can be judged from a later section which gives details furnished by them of investigations on the burning of residual grades of fuel.

RESEARCH ASSOCIATIONS

Pametrada. Marine turbine propulsion machinery in Britain is generally produced by engine works belonging to the shipbuilding companies or closely associated with them. These firms have formed The Parsons and Marine Engineering Turbine Research and Development Association (Pametrada) to carry out research and development on steam- and gas-turbine machinery and transmission. At present it is the only research association actively engaged in marine gas-turbine research, although others such as the British Internal Combustion Engine Research Association and the British Shipbuilding Research Association are concerned with various aspects of the problem. Pametrada has built a long-life gas-turbine propulsion set of 3500 shp output at 85 rpm. The association, as already noted, has also received contracts from the Admiralty.

Apart from steam and gas-turbine research, Pametrada is engaged in testing fluid couplings, helical reduction gearing, and auxiliaries associated with gas-turbine work, so that the whole question of starting, maneuvering, and running gas-turbine machinery at sea can be explored fully. The association has the largest capacity for testing high-powered machinery in Britain. The large brake installed can absorb powers up to 60,000 shp per shaft at 160/360 rpm. Fig. 1 shows this brake coupled to steam-turbine machinery. The research station is equipped with boilerhouses, pumps, air compressors, etc., and is described elsewhere (2).

Independent research is also carried out by the member firms

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Gas Turbine and Power Divisions and presented at the Spring Meeting, Washington, D. C., April 12–14, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

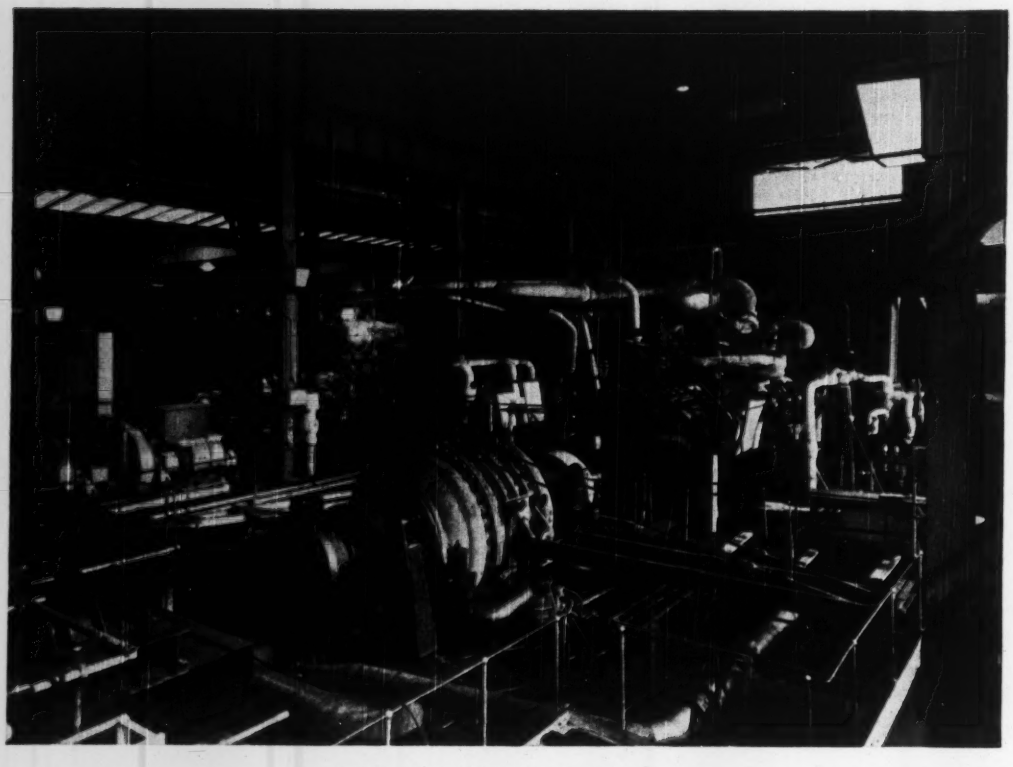

FIG. 1 PAMETRADA TURBINE TESTING HOUSE

of Pametrada, such as Messrs. C. A. Parsons & Company, which has a large research department, The Parsons Marine Steam Turbine Company, Messrs. Vickers-Armstrongs, and Messrs. John Brown & Company. This latter firm is particularly interested in gas-turbine work and has made a license agreement with Messrs. Escher Wyss. The company is constructing a closed-cycle gas-turbine plant to develop 12,500 kw, which will provide experience to enable a marine-gas-turbine set to be constructed.

Private Firms. Many large firms, such as The British Thomson-Houston Company, The Metropolitan-Vickers Electrical Company, Messrs. Rolls-Royce, The English Electric Company, and The General Electric Company also have considerable research facilities. From Table 1 it will be seen that four of these firms are actively engaged in the production of gas turbines for marine propulsion. This work is largely in connection with Admiralty contracts and so far there has been no general pooling of information.

TABLE 1 BRITISH GAS TURBINES UNDER DEVELOPMENT FOR MARINE PROPULSION; ALL OPEN CYCLE

Firm	Horse-power	Life	Generator or main output shaft, rpm	Duty
Metro-Vickers	2500	Short	1087	Naval
Metro-Vickers	4800	Medium		Naval
English Electric	6000	Long	5600[a]	Naval
Rolls Royce	6000	Medium		Naval
Pametrada	15000	Long	300	Naval
Pametrada	3500	Long	85	Merchant
British Thomson-Houston Company	1200	Long	3000[a]	Merchant

[a] Electric speed reduction.

WHY DEVELOP GAS TURBINES FOR MARINE PROPULSION?

Why is it considered important to develop gas-turbine machinery for marine propulsion? Already the efficiency of gas-turbine propulsion projects is greater and the weight less than steam-turbine units developing the same power. While occupying considerable volume, the component parts can be assembled in various ways to suit the space available. The particular cycles employed also can be chosen to suit the service requirements of the vessel more easily than with other types of machinery. Furthermore, gas-turbine machinery can be on full load in a matter of minutes in contrast to steam-turbine machinery where raising steam may require an hour or two. The gas-turbine plant requires few external auxiliaries. These are advantages applying to present designs, and the promise for the future is even better.

MAIN REQUIREMENTS FOR MARINE PROPULSION BY GAS TURBINES

For marine propulsion machinery the fundamental requirement is reliability, and gas-turbine machinery must conform.

There is no other way of proving this except by constructing gas-turbine machinery and trying on the test bed until it is considered proper to install it in a ship. Careful testing, including the simulation of maneuvering conditions on the test bed, may give a guide to subsequent behavior, but behavior under service conditions will be considered the only proof.

At present, unless cooling is provided, designs for long-life machinery can be developed only by utilizing values of stress extrapolated from stress-creep results on specimens up to 10,000 hr, and then making comparatively short creep and strength-to-rupture tests on specimens taken from the actual rotors, casings, and blading. By comparing these results with the corresponding values from the original specimens on which extended periods of tests have been completed, some idea of probable life is obtained.

LIFE REQUIREMENTS

For merchant-ship machinery life requirements are 100,000 hr at full power, which corresponds to about 20 years' service of the machinery, on the assumption of 200 days per year at sea. During this time as few of the machinery parts as possible should be expendable. There are, however, specialized ships such as those used for "Cross Channel" work where high powers are required for short periods. Consequently the life of the machinery does not require to be so long; 20,000 hr life at full power probably would be adequate. Hence higher temperatures and a simpler cycle might suffice, leading to reduction in machinery weight.

In naval vessels extensive life is required at cruising powers, but the life at full power can be comparatively short. This point is exemplified in Fig. 2 in which the diagram for a destroyer by Michel has been transposed from a speed base to a base of power. The extreme importance of economy at powers below 40 per cent of full power for naval machinery is clear. This could be met by providing a high-efficiency cruising unit with a simpler set for full power.

There is also the extreme case of small high-speed naval craft operating in coastal waters where light weight is of major importance. For this the gas turbine is the best type of machinery since for short life and small radius action lightweight machinery can be produced operating at fairly high temperatures, with the layout so arranged that new or rebuilt engines can be substituted readily. The cycle can then be the simple one of compressor, combustion chamber, drive turbine for compressor, output turbine exhausting to atmosphere used in the M.G.B. 2009. At the other end of the scale is the merchant liner on runs from, say, Britain to Australia, where efficiency is of prime importance. As temperatures for a life of 100,000 hr have to be governed by reasonable stresses to a figure of about 1250 F, a complex and relatively heavy gas-turbine unit has to be employed in such service.

TABLE 2 COMPARISON OF WEIGHTS AND PERFORMANCES OF VARIOUS TYPES OF MERCHANT-SHIP PROPULSION MACHINERY

Type of plant	Present-day Diesel direct coupled	Present-day steam plant	Present-day gas-turbine plant: Open cycle	Present-day gas-turbine plant: Closed cycle	Future steam plant	Future gas-turbine plant
Size of plant:						
Shaft horsepower	6600	10000	10000	6800/7500	10000	10000
Revolutions per minute	114	120	120	120	120	120
Maximum pressure, psig	520	600	162	400	1100	73
Maximum temperature, deg F	3200	850	1250	1250	1200	2200
Vacuum, in. Hg	....	28½	....	....	28½	....
Weights: Turbines	....	6 + 15 = 21	25		3.5 + 4.5 + 11 = 19	15
Weights: Condenser	....	23	....		18	4
Weights: Boilers	....	180	....		22	....
Weights: Compressors	....	....	16		4	9
Weights: Combustion chambers	....	....	17		.....	10
Weights: Heat exchanger	....	....	46	148	.....	25
Weights: Intercoolers	....	....	11		.....	4
Weights: Ducting	....	....	28		.....	11
Weights: Bedplates	....	....	17		.....	7
Weights: Gearing	....	66	60	55	19	19
Total weight—main machinery (including boilers)	404	290	220	203	82	105
Stern gear, shafting, and propeller	100	160	160	110	160	160
Auxiliaries, including generators	140	190	190	150	190	190
Ladders, gratings, floor plates, funnel, tanks and piping, spare gear, etc.	160	250	210	180	200	200
Total dry weight	804	890	780	643	632	655
Water and oil in system	30	50	20	18	20	15
Total "steam-up" weight	834	940	800	661	652	670
Horsepower/ton (dry weight)	8.2	10.6	12.5	10.3/11.3	15.3	14.9
Length of engine room (single screw assumed) 60 ft beam, ft	66	52	54	55	35	35
Thermal efficiency, per cent (based on HCV and including transmission loss):[a]						
Full load	38	27.2	30.9	31	30.7	40.9
Half load	36	24.8	28.5		27.9	39.7
Fuel rate, lb per shp per hr (HCV = 18500 Btu per lb):[a]						
Full load	0.36	0.505	0.445	0.44	0.45	0.34
Half load	0.38	0.555	0.48		0.49	0.35
Fuel rate (including auxiliaries), lb per shp per hr:						
Full load	0.39	0.58	0.49	0.47	0.52	0.37
Half load	0.41	0.64	0.53	....	0.565	0.38

[a] Excluding auxiliaries.

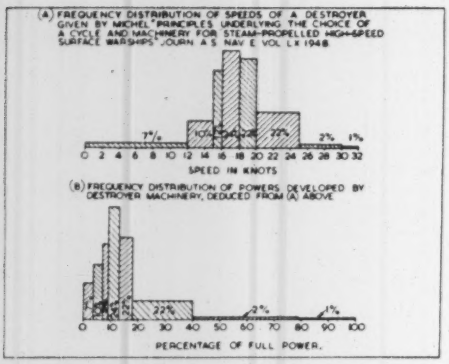
(A) FREQUENCY DISTRIBUTION OF SPEEDS OF A DESTROYER GIVEN BY MICHEL "PRINCIPLES UNDERLYING THE CHOICE OF A CYCLE AND MACHINERY FOR STEAM-PROPELLED HIGH-SPEED SURFACE WARSHIPS" JOURN A S NAV E VOL LX 1948
7%
10%
22%
2%
1%
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
SPEED IN KNOTS
(B) FREQUENCY DISTRIBUTION OF POWERS DEVELOPED BY DESTROYER MACHINERY, DEDUCED FROM (A) ABOVE
22%
2%
1%
0 10 20 30 40 50 60 70 80 90 100
PERCENTAGE OF FULL POWER.

FIG. 2 FREQUENCY DISTRIBUTION OF SPEEDS AND POWERS OF A DESTROYER

Fig. 3 summarizes the relation between specific weight and specific fuel consumption on a base of life for present-day gas-turbine installations. They can be taken only as average figures in the power range 2000–7000 shp, but they do emphasize the fundamental effect of life on design.

As an example of present-day design for 100,000 hr life, an open-cycle gas-turbine propulsion unit of 3500 shp, which develops its power at 85 main shaft revolutions per minute, is shown in Fig. 4. A low-pressure axial-flow compressor draws air from the atmosphere and delivers to an intercooler from which a high-pressure compressor discharges the air to a tubular heat exchanger. The air heated by traversing the tubes

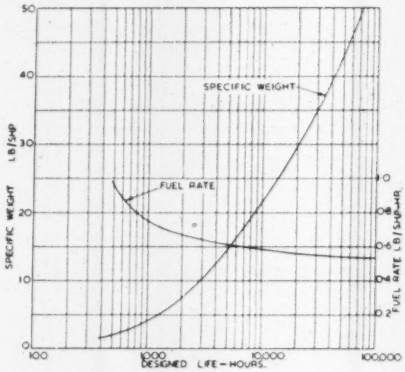

FIG. 3 FUEL PER SHAFT HORSEPOWER PER HOUR AND SPECIFIC WEIGHT OF PRESENT DESIGNS OF GAS-TURBINE MACHINERY IN RELATION TO DESIGNED LIFE

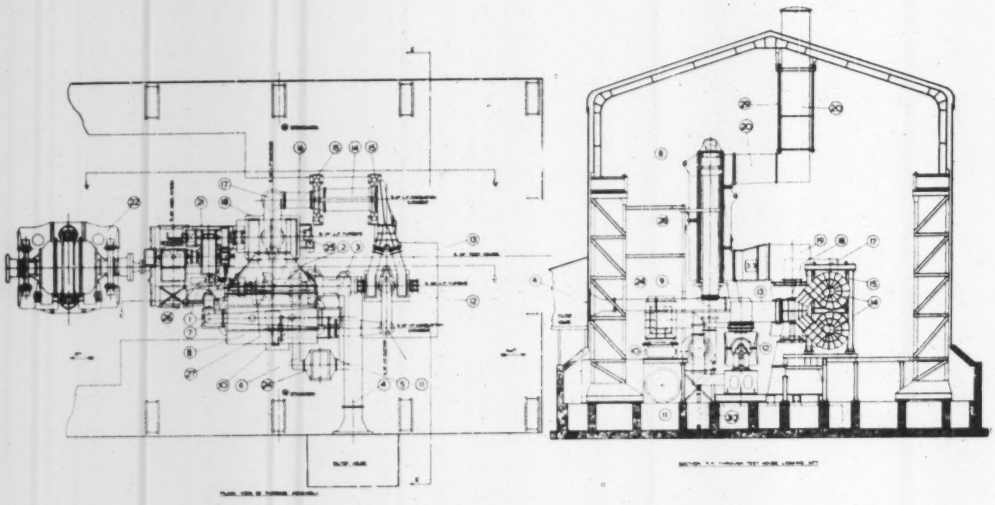

FIG. 4 LAYOUT OF 3500-SHP PAMETRADA GAS-TURBINE PROPULSION UNIT

1 Starting turbine
2 H P compressor
3 L P compressor
4 Air intake duct to L P compressor
5 Duct from L P compressor to intercooler
6 Duct from intercooler to H P compressor
7 Duct from H P compressor to heat interchanger
8 Heat interchanger
9 Duct from heat interchanger to H P combustion chamber
10 H P combustion chamber
11 Duct from H P combustion chamber to H P turbine
12 H P turbine
13 Exhaust duct from H P turbine to L P combustion chamber
14 L P combustion chambers
15 L P combustion-chamber cradle
16 Gas mixer unit
17 Duct from gas mixer unit to L P turbine
18 L P turbine
19 Exhaust duct from L P turbine to heat interchanger
20 Exhaust duct to atmosphere
21 Gear case
22 Dynamometer
23 Oil fuel heater
24 Intercooler
25 Turning gear for L P turbine
26 Turning gear for gearing
27 Turning gear for compressors and H P turbine
28 Support for heat interchanger
29 Spring supports for exhaust duct
30 Spring supports for H P combustion chamber and duct
31 Spring supports for L P combustion-chamber duct

then passes to the primary combustion chamber on its way to the high-pressure turbine which drives the compressor line. The gas exhausted from the turbine passes through reheaters before entering the output turbine, from which it passes through the heat exchanger to atmosphere. Particulars of the cycle are given in reference (3). This unit is now on test and experience is being gained in its operation.

The output could be doubled by exhausting the output turbine to a simple turbine driving a supercharger, which for simplicity could be of the centrifugal type, so that the air is delivered at a pressure of 2 atm to the first axial compressor. The output turbine then becomes the intermediate-pressure turbine in the expansion of the gas. This supercharging unit is shown fitted in Fig. 5 (*c*). The weight is increased by only 10 tons, and the cycle efficiency is also improved to 31 per cent at the output shaft.

COMPARISON OF GAS-TURBINE UNITS WITH DIRECT-COUPLED OIL-ENGINE AND STEAM-TURBINE SETS

For merchant-ship propulsion, the two most usual types of machinery used in the region of 7000 shp are the direct-coupled oil engine, and the steam turbine, which are contrasted with a closed-cycle gas-turbine unit and an open-cycle one of about the same power. Fig. 5(*a*), (*b*), (*c*), and (*d*), gives the relative lengths and volumes occupied by these four types of machinery drawn to the same scale. The weights of the main-engine units are (*a*) direct-coupled Diesel, 404 tons, (*b*) John Brown Escher-Wyss closed-cycle unit, 203 tons, (*c*) open-cycle unit, 178 tons, and (*d*) steam turbine and boilers, 236 tons, respectively. In actual complete machinery layouts, the auxiliaries, particularly when Diesel generators are fitted, may alter the relative engine-room lengths to something nearer equality for all these types. In comparisons this point may be overlooked.

In Table 2 an attempt has been made to examine the relative weights of the complete installations and to give efficiencies and fuel consumptions not only for the oil engine and closed-cycle gas turbines at outputs of 6600 shp and 6800/7500 shp, respectively, but also for a steam turbine and open-cycle gas turbine of present design of 10,000 shp output. Two further columns of figures which will be referred to later have been added giving particulars of a future steam-turbine design and also a future open-cycle gas turbine to operate at 2200 F temperature at inlet to the turbine. It will be seen that on a basis of dry weight for the whole machinery installation, the present horsepower per ton figures varying from 8.9 to 12.5 will improve to about 15 in future steam- or gas-turbine plant, although the weights other than main-engine weights have a great influence on this figure. The figures for length of engine room should at this stage be taken only as an indication of what may be achieved.

In every case the auxiliaries are taken to have electric drive, except where associated with the steam cycle in the matter of air ejection and feed heating, the power to be supplied in all cases by Diesel-driven generators. This has been done deliberately to eliminate the effect of auxiliaries in a comparison of this type.

MAIN PROBLEMS TO BE ELUCIDATED IN DEVELOPMENT OF THE GAS TURBINE

In the development of the gas turbine for marine propulsion, the main research required is to establish the ability to burn heavy fuel without fouling or corroding the turbine blading or heat-exchanger surfaces. As long as efficiencies of the order of 30 per cent are all that can be obtained, and the production cost of gas-turbine units is high, it is essential that gas-turbine units should be capable of burning boiler oil of the same quality as

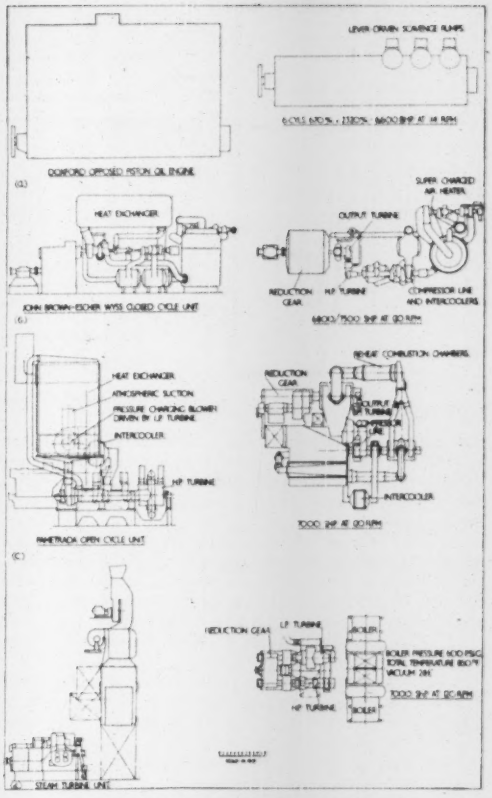

FIG. 5 DIAGRAM SHOWING COMPARISON OF SIZE OF MERCHANT-SHIP MACHINERY OF ABOUT 7000 SHP

(*a*, Direct-coupled Diesel engine; *b*, John Brown-Escher Wyss closed-cycle gas turbine; *c*, Pametrada open-cycle gas turbine; *d*, geared steam-turbine machinery.)

that used in furnaces of boilers in steam-turbine-driven vessels.

The problem is so important that the Admiralty has commissioned many researches on it, including contracts placed with Pametrada. It has provided the following statement for inclusion in this paper:

"The field of study has been regarded as divided into six groups, each of which is briefly remarked upon below:

"1 *Fuel Characteristics.* In order to evaluate the problem, a survey is being carried out aimed at giving a comprehensive picture of the nature of the ash forming constituents of crude oils from the various world sources.

"Work is also in progress on the problem of developing economical and efficient methods of removing undesirable impurities from residual fuels prior to combustion.

"2 *Atomisation:* An extensive research programme is in progress to determine the factors affecting efficient atomisation of viscous fuels; rig tests of various types of burner and tests on aircraft-type gas-turbine engines provide complementary information.

"3 *Combustion:* Cyclone chambers designed to remove ash

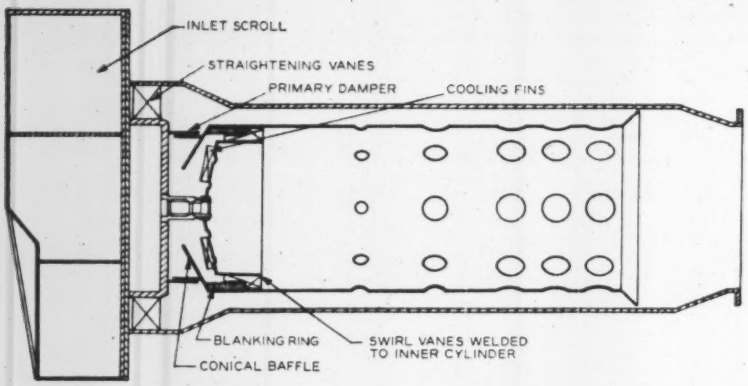

FIG. 6 DIAGRAM OF ALL-METAL COMBUSTION CHAMBER

from the products of combustion are under active development by N.G.T.E. More orthodox types of combustion chamber designed primarily for use with residual fuel are also to be tested. Some combustion work on aircraft-type gas-turbine engines has been carried out.

"4 *Heat Transfer:* A study of the radiation characteristics of heavy fuel flames and the means of evaluating flame tube, etc., temperatures by heat-transfer calculations has been undertaken with particular reference to the elimination of "cold spots" upon which carbon deposits might form.

"5 *Blade and Heat Exchanger Fouling:* Tests on static blades are being carried out and the composition of deposits and their metallurgical effects are being studied. Aircraft-type engines designed for operation of distillate fuel are being run for extended periods on residual fuel to obtain practical data on fouling effects under various conditions of flow.

"A study of the best means of removing deposits from blading and heat exchangers is contemplated.

"6 *Materials:* Work is in hand on the effects of the commoner types of impurities of residual fuel, viz., compounds of sulphur, sodium and vanadium upon the structure and properties of the high-temperature materials used in gas turbines.

"In addition specimen blades from static and engine fouling tests receive detailed metallurgical examination."

While auxiliaries generally have been neglected in this paper, thanks to the kindness of the Admiralty, the Appendix gives a statement on gas turbines for power generation in warships. The firm of Messrs. W. H. Allen has kindly allowed Fig. 11 to be included in the paper, and has otherwise assisted in compiling the statement given in the Appendix.

PRESENT AND FUTURE TRENDS IN GAS-TURBINE COMPONENTS

Combustion Chamber. The type of combustion chamber of all-metal construction shown in Fig. 6 is typical of present-day British practice. Air from a heat exchanger enters at a temperature of 700–800 F, depending on the cycle, and leaves at 1250 F, the air-fuel ratio being about 150:1 by weight.

Without attempting to forecast in detail the future trends of combustion-chamber design to meet the conditions of high turbine-inlet temperature, certain probable lines of development can be anticipated. The air-fuel ratio would be greatly reduced (probably about 60:1 for a temperature of 2200 F), so that the perforated dilution zone of the flame tube could be partly dispensed with. Again, the increased air-inlet temperature would permit the use of a greater excess of air in the combustion zone to prevent the flame temperature from becoming too high. In order to improve the cooling it might be necessary to increase velocities throughout the chamber, accepting the accompanying increase in pressure loss, and chambers would thus become smaller with higher heat-release rates. New flame-tube configurations are also likely to be developed with the object of achieving more effective cooling of the walls. Refractory materials are already being used as a means of protection against overheating, although slagging troubles may arise. On the whole, however, an all-round rise in the level of temperatures in the chamber seems likely to encourage the use of refractories or the use of porous walls in the liner at the hottest zones, cooled by air taken directly from the high-pressure-compressor discharge, thus partly by-passing the heat exchanger.

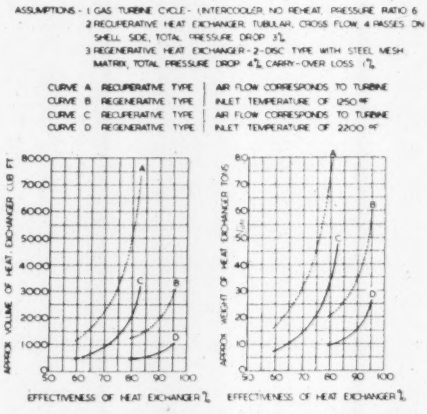
ASSUMPTIONS - 1 GAS TURBINE CYCLE - INTERCOOLER, NO REHEAT, PRESSURE RATIO 6
2 RECUPERATIVE HEAT EXCHANGER, TUBULAR, CROSS FLOW, 4 PASSES ON SHELL SIDE, TOTAL PRESSURE DROP 3%
3 REGENERATIVE HEAT EXCHANGER - 2-DISC TYPE WITH STEEL MESH MATRIX, TOTAL PRESSURE DROP 4%, CARRY-OVER LOSS 1%
CURVE A RECUPERATIVE TYPE | AIR FLOW CORRESPONDS TO TURBINE
CURVE B REGENERATIVE TYPE | INLET TEMPERATURE OF 1250°F
CURVE C RECUPERATIVE TYPE | AIR FLOW CORRESPONDS TO TURBINE
CURVE D REGENERATIVE TYPE | INLET TEMPERATURE OF 2200°F
APPROX VOLUME OF HEAT EXCHANGER CU FT
APPROX WEIGHT OF HEAT EXCHANGER TONS
EFFECTIVENESS OF HEAT EXCHANGER %
EFFECTIVENESS OF HEAT EXCHANGER %

FIG. 7 COMPARATIVE SIZES AND WEIGHTS OF RECUPERATIVE AND REGENERATIVE HEAT EXCHANGERS

Compressors. Compressors also require further development to achieve higher efficiencies. Most gas turbines in Britain utilize axial compressors with over-all efficiencies of 84–86 per cent, but the results obtained by Oerlikon with centrifugal compressors must not be overlooked. It would appear, however, that the multistage centrifugal of high efficiency is considerably bulkier than axial compressors with the same through-

put. If the compressor line is independent of the output shaft and therefore does not work through a large speed range, the danger of stalling with axial compressors even at low part-load conditions is greatly reduced.

Heat Exchangers. Another component which is receiving a considerable measure of attention is the heat exchanger. With open-cycle gas turbines, if the heat exchanger is of tubular construction, it is bulky and heavy when high effectiveness is required. Curves A in Fig. 7 give the volume and weights for recuperative or tubular heat exchangers for the given cycle operating at a maximum temperature of 1250 F. Curves B show how much reduction in volume and weight can be achieved by the use of regenerative heat exchangers. Little work in Britain is being done on recuperative types of heat exchangers with secondary surfaces, as the curves would lie nearer A than B. Such heat exchangers are considered more difficult to maintain clean in service and the promise of regenerative heat exchangers being developed at an early date is good. These regenerative heat exchangers can be expected to have some self-cleaning properties owing to the alternating reversal of flow of air and gas through the matrices.

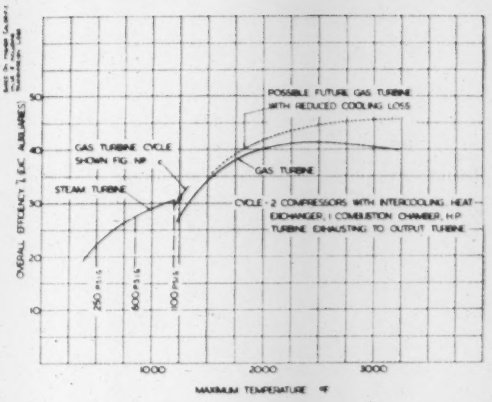

FIG. 8 THERMAL EFFICIENCIES OF STEAM AND GAS TURBINES ON A BASE OF TEMPERATURE

FUTURE TRENDS IN STEAM AND GAS TURBINES

The most promising line of development for gas turbines lies in the use of higher inlet temperatures. It is not expected that materials suitable for the construction of rotors and casings will be developed to allow large increases in metal temperature to be utilized. Fortunately, this is not necessary. In the development of the Diesel engine good results were not obtained until water cooling had been used. Similarly, it is felt that higher inlet temperatures in gas turbines with air or water cooling, or both, will be required. In another paper (6), the author has derived equations to enable the cooling loss to be estimated and shows that, with a gas-inlet temperature of 2200 F, a blade speed of 800 fps can be used while maintaining a maximum surface temperature of the blading in the rotor at 800 F.

It is also shown that it is better to use fairly high blade speeds and low surface temperatures on blades and rotor (which enable reasonable stresses to be employed), rather than to allow higher surface temperatures with the consequent necessity of using lower stresses in the design. Higher blade speed is also required to give critical pressure in the water at the tips of the rotor blading.

The stator blades would be of ceramic or similar material developed to have high resistance to thermal shock. The cooling loss then would be partially recovered by utilizing the steam produced either in a separate turbine to produce power or by means of jet refrigeration (8), to cool the incoming air. The consequent thermal efficiency for the gas turbine with auxiliary steam turbine based on the HCV and including transmission loss, is shown in the full-line curve in Fig. 8. The upper curve of efficiency involves the production of improved blading and running at higher blade speeds from the point of view of reduction in cooling loss. On the same diagram the thermal efficiency of a steam turbine has been plotted. Both efficiencies are given, excluding auxiliaries, but in the case of the steam cycle including three stages of feed heating and a boiler efficiency of 87 per cent. The steam turbine has pressure combustion in the boiler, the pressure being about $3^1/_2$ atm in the furnace. A gas turbine driving the blower would take gas from the boiler at a temperature of 500 F, and expand it to a temperature of about 270 F to atmosphere. A small motor would be provided to start up the gas-turbine-driven compressor. Pressure combustion does not have any great effect on the over-all efficiency as it is not greatly affected by the efficiencies of the turbine and compressor, but the use of pressure combustion would reduce the weight and space required for the boilers materially.

In the design of the boiler a boiler efficiency of 88 per cent should be possible and a lower weight might be achieved than that given in Table 2.

Other figures applying to the steam cycle are given in Table 2. The curves in Fig. 8 are produced for merchant-ship designs of steam and gas turbines of 10,000 shp per shaft.

If auxiliaries are taken into account, the efficiency of the steam turbine will flatten out and temperatures much in excess of 1200 F will result in diminishing gains, while the temperature limit for materials used in superheaters, and so forth, will be reached rapidly. The steam turbine has still a considerable way to go in development, but it will reach its limiting temperature sooner than the gas turbine. The complex gas turbine shown in Fig. 5 (*c*), and Table 2 at 1250 F will improve rapidly with increase in temperature, but will not be suitable for immediate development when cooling is introduced. The more simple cycle used to provide the curves in the high-temperature region in Fig. 8 will probably be adequate until experience has been gained.

It may be remarked that a large change in air rate also occurs with increasing temperature. For the cycle in Fig. 8 an air rate of 60 lb per shp per hr is required at 1250 F, but at 2200 F the corresponding figure is 20 lb per shp per hr. An existing compressor would be capable of providing the air required for a gas-turbine unit developing 3 times the power at the higher inlet temperature. Similarly, the heat exchanger would also be reduced in size and in weight to the curves C and D for recuperative and regenerative types, respectively, as shown in Fig. 7.

FUTURE GAS-TURBINE DESIGNS

The most striking change would be in the turbines themselves. For this simple cycle a high-pressure and a low-pressure turbine are shown in Fig. 9, to drive compressors and provide output power with an inlet temperature of 1250 F. The corresponding turbines operating at an inlet temperature of 2200 F are shown also. It will be seen that less than one half the power is required to drive the compressors, and that both turbines are small enough to be mounted independently in a common outer casing. Forgings of the size shown in the upper part of Fig. 9 have not yet been produced, but it is suggested that the necessity to produce them will never arise. Both out-

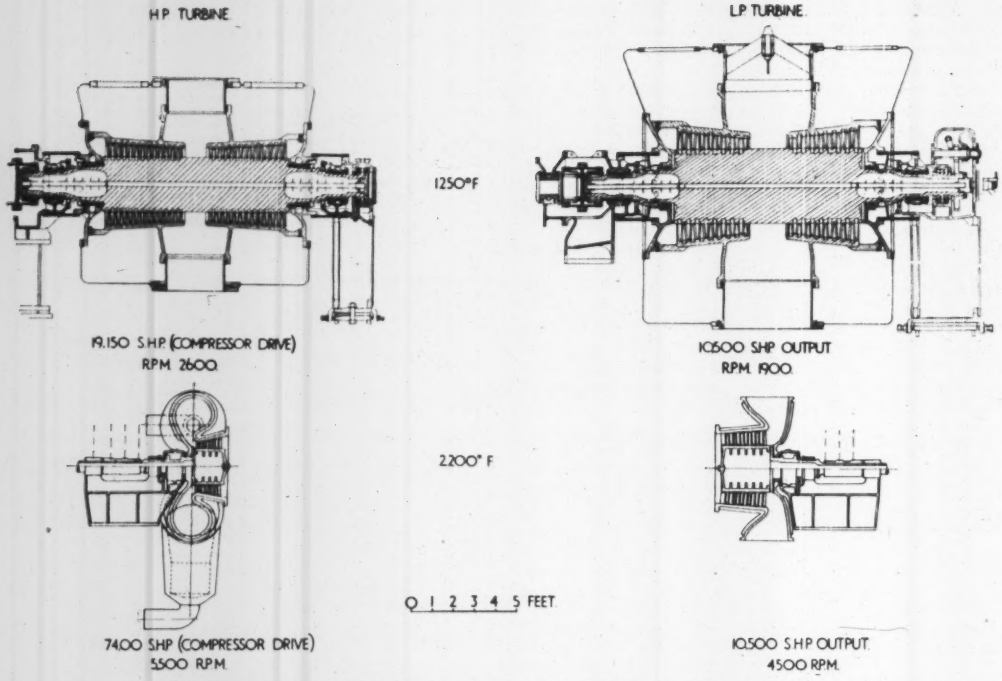

FIG. 9 COMPARISON OF TURBINE SIZES WITH INLET TEMPERATURE OF 1250 F AND 2200 F

put turbines are designed to develop 10,500 shp, which would give 10,000 shp at the main shaft after allowing for transmission losses. With the high inlet temperature the multiple combustion chambers have to be mounted on the turbine-inlet scroll, and the casings joined so that no duct work is required to carry gas at high temperature. It may be remarked that with an inlet temperature at full load of 2200 F, the part load-efficiency figures for such a gas turbine are very good, being above 37½ per cent at 40 per cent power, as a reduction in the cooling loss nearly compensates for the reduction in cycle efficiency due to the lower inlet temperature. The pressure at the blade tips is no longer in the critical region, less heat is transmitted, and the surface temperature of blading and rotor rises slightly reducing further the temperature difference between gas and cooled surfaces. As, however, the centrifugal loading is decreased, the strength properties of the materials are adequate.

These considerations apply to a marine set with the output turbine coupled through gearing to a propeller.

MANEUVERING AND TRANSMISSION SYSTEMS

No discussion on the present or future of marine gas-turbine propulsion sets would be complete without consideration of the means of coupling the output turbine to the propeller, not only from the point of view of speed reduction, but also from that of ability to maneuver. Electric speed reduction is well tried and reliable but is heavy, complicated, and bulky. The best speed-reduction method at present is by means of double-reduction double-helical gearing. Fig. 10 shows a locked train gearbox to transmit 10,000 shp at 4500 rpm to a speed of 120 rpm at the main shaft. This method is lighter, cheaper, and simpler than electrical transmission and operates with efficiencies of the order of 97–98 per cent. Great efforts have been made to improve the accuracy of production of these gears, and reliability is high in consequence.

One of the necessities in marine propulsion machinery is the ability to maneuver with certainty from ahead to astern at all powers required by telegraph. Separate astern turbines, the method generally used with steam turbines, is not likely to be employed in gas turbines, as if direct-coupled the windage in the astern casings when running ahead would be considerable.

The control valves would also be of considerable size, as the gas density in most cycles is low compared with steam, and therefore would be difficult to maintain tight. A reversible propeller would be a better solution, but the mechanism in the propeller boss is vulnerable, and the efficiency lower than for a well-designed fixed-pitch propeller. Fig. 10 shows another solution, employing an ahead coupling and torque converter for astern running with the output turbine directly coupled by means of a quill shaft to the driving members, and the driven members attached to the pinion. They are fitted to the high-speed shaft to minimize the size, since at this point the torque is a minimum.

The other gearbox shows one possible future trend of gearing by the use of reversible elements in an epicyclic gearbox, either the ahead or astern outer rings being stopped by means of brakes.

The gearbox transmits the same power as that shown in the usual double-reduction helical gear. High-alloy materials are employed in the gearbox and the gears.

The steam turbine shown in the table operating at 1200 F

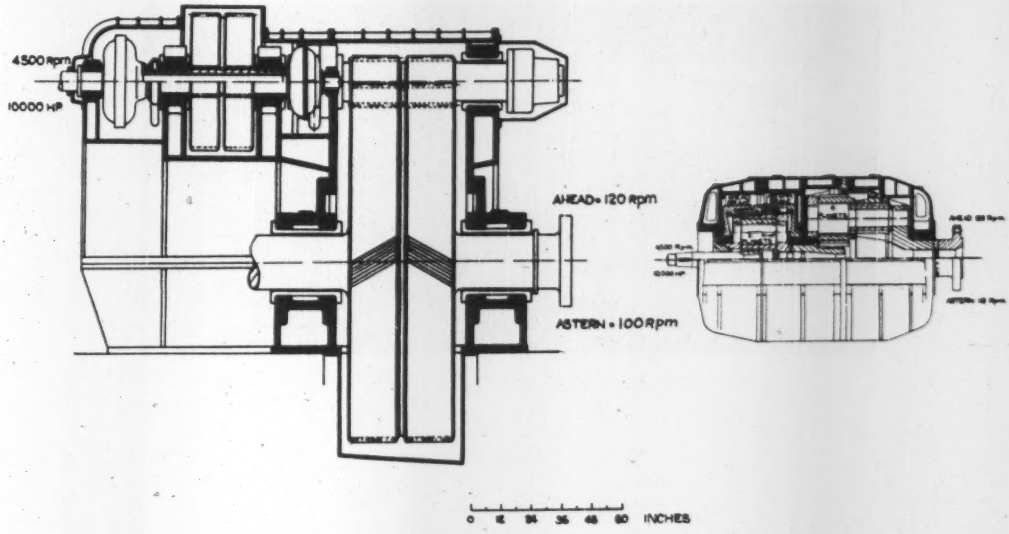

FIG. 10 COMPARISON OF DOUBLE-REDUCTION GEARBOX WITH AHEAD OIL COUPLING AND TORQUE CONVERTER FOR ASTERN RUNNING WITH EPICYCLIC GEARBOX HAVING BUILT-IN MANEUVERING BRAKES

would employ unidirectional turbines coupled to the propeller shaft in the same way as in a gas turbine, and astern turbines, maneuvering valves, and astern piping would be eliminated.

CONCLUSION

The economics of the direct-coupled oil engine and the steam turbine have been dealt with in many papers. It is not possible, however, to show the position of the gas turbine in relation to these other forms of main propulsion machinery as it is still in the experimental or development stage. Costs so far available would be completely misleading. Dealing, therefore, only with the technical aspects, it is felt that the gas turbine operating at 1250 F can already compete in running costs with steam and oil-engine machinery so long as the oil engine burns distillate fuel, and provided the gas turbine can burn boiler fuel.

Considering possible lines of future endeavor it is felt that some of the developments on gas turbines to operate at 1250 F will largely apply also to steam-turbine machinery. It is only when really high temperatures can be employed in the gas turbine by the application of cooling that it then has the field to itself from the point of view of thermal efficiency, although a small steam turbine will remain in conjunction with the gas-turbine machinery to enable the heat abstracted from the gas by water cooling to be employed usefully.

The future of main propulsion machinery depends not only on technical considerations, but also upon the price differentials between boiler oil and distillate fuel. Should the heavy-oil engine burn boiler oil it will remain competitive until gas turbines have been produced at reasonable cost. It is also clear that improvements in gearing and the ability to maneuver provided in the gear cases will assist both steam and gas-turbine machinery when high temperatures are employed.

Steam turbines to operate at a temperature of 1200 F are not many years away, but gas turbines to operate at 2200 F or more may be 5 or 10 years in the future.

ACKNOWLEDGMENTS

The author thanks the Council of Pametrada for permission to present this paper, and the British Admiralty for the statement on "The Combustion of Residual Fuels in Marine Gas Turbines." The Admiralty provided the information on gas turbines for power generation in warships, and the author would also thank Messrs. W. H. Allen for agreeing to its inclusion, together with Fig. 11 showing the unit. The author is grateful to Mr. T. A. Crowe of Messrs. John Brown & Company for information about the John Brown - Escher Wyss turbine.

The paper is to be taken as the expression of the opinion of the author who has been considerably aided by many of his colleagues at Pametrada.

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FIG. 11 ALLEN GAS TURBOALTERNATOR DEVELOPED FOR POWER GENERATION IN WARSHIPS

Steam Propelled High Speed Surface Warships," by R. Michel, *Journal of the American Society of Naval Engineers*, vol. 59, 1948, pp. 292–315.

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Appendix

GAS TURBINES FOR POWER GENERATION IN WARSHIPS

The advent of the gas turbine as a practical prime mover, with its potential advantages of low maintenance, compactness, and light weight, in addition to those of self-contained operation and quick starting already associated with Diesel-driven generators, has led the Admiralty to consider the possibility of developing a gas turbogenerator suitable for naval vessels.

The fuel consumption of gas turbines in their present stage of development, especially when designed for long operating life, is high compared with the Diesel, although comparable with ship's steam turbogenerators. Practical experience is necessary to determine the extent to which high fuel consumption is outweighed by the advantage mentioned.

The Admiralty has, therefore, placed a contract with Messrs. W. H. Allen, Sons & Company Ltd., of Bedford for a 1000-kw gas turbine and generator for base-load operation. The set is being designed in collaboration with the Bristol Aeroplane Company with whom Messrs. W. H. Allen have a design consultancy agreement.

This set consists of an axial compressor of 4.1 pressure ratio, delivering to an annular-type heat exchanger, a compressor-turbine and a free power turbine. While the free power turbine complicates the governing problem, it does give a necessary improvement in part-load performance. The generator is driven through an epicyclic reduction gear.

The arrangement of the complete unit is indicated in the photograph of a model of the set.

The following performance details are available:

Maximum continuous rating, kw	1000
10-min rating, kw	1200
Fuel	Diesel oil
Estimated fuel consumption at full load, lb per kw per hr	1.07
Maximum gas temperature (tropical conditions) deg C	720
Operating life, hr	50000
Overhaul periods, hr:	
Major	5000
Minor	1000

The set has been designed for operation in both temperate and tropical conditions. Allowance has been made for very high inlet and exhaust losses associated with long trunking in shipboard operation.

The design and construction of this Allen gas-turbine-driven generator is well advanced, and it is expected that development running of the prototype engine will begin early in 1951, upon completion of preliminary tests during the autumn of 1950.

IN the Trueman Wood lecture on "The Industrial Applications of Atomic Energy," which was delivered before the Royal Society of Arts on Wednesday, March 8, Prof. M. L. Oliphant dealt mainly with the possibility of generating power in large fixed reactors and its subsequent distribution as electrical energy. At first sight the production of atomic energy for industrial purposes was not encouraging. Of the two fast and slow types of neutron reactors, the fast required concentrated fissile material, which was difficult and expensive to produce. The slow reactor utilized only a small fraction of the rarer isotope of uranium and produced the same quantity of plutonium. A fission process, releasing several neutrons, say, three, one of which could be utilized to produce a fresh fission by absorption into the nucleus of another fissile atom was, however, possible. The second neutron could then be captured by uranium of mass 238 to produce an atom of plutonium, thus replacing the atom of fuel which had been used. The third neutron could be absorbed by a second uranium 238 atom to give another plutonium atom. Such a reactor produced more nuclear fuel than was burnt and was called a "breeding reactor." It made the utilisation of the whole of the uranium possible and in time should enable a change over to the more plentiful thorium as a fuel to be effected for the production of nuclear power. The Atomic Energy Commission of the United States had announced the construction of two types of breeding reactor, one of which was designed to investigate the feasibility of breeding with fast neutrons and the application of liquid metals to the removal of fission-produced heat at high temperatures. The second was to be employed to determine whether breeding was possible in a reactor using neutrons in the intermediate range of energies.—*Engineering*, March 10, 1950, p. 273.

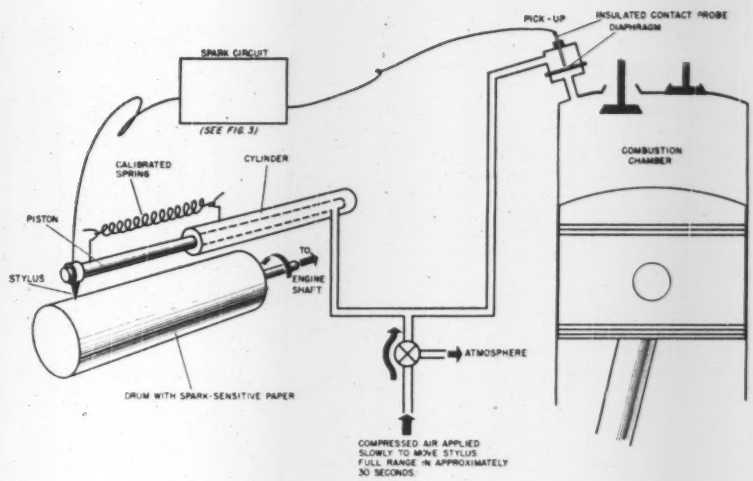


FIG. 1 ELEMENTS OF INDICATOR

BALANCED-PRESSURE ENGINE INDICATOR

Development and Use of New Electronic Circuit

By D. R. CHURCH AND D. K. HART[1]

U. S. NAVAL ORDNANCE LABORATORY, SILVER SPRING, MD.

ONE of the most popular instruments for obtaining indicator cards on reciprocating engines, compressors, pumps, and the like, is the balanced-pressure indicator. The basis for this method of indication consists of a pickup transducer containing a diaphragm exposed to the engine cylinder pressure (or manifold pressure, and so forth) on one side and an applied calibrated pressure on the other. When the cylinder pressure exceeds the applied pressure, the diaphragm deforms to close an electrical circuit. Likewise, when the cylinder pressure diminishes the circuit is broken. An electrical circuit is required to convert the resulting pulses into a visible trace; this is accomplished by inducing a spark through spark-sensitive paper each time the diaphragm makes or breaks contact.

A stylus, which comprises one side of a spark gap, is mounted on, or actuated by, a pressure-sensitive servo (such as a piston-cylinder or Bourdon-tube arrangement), which is motivated by the same calibrated pressure as applied to the pickup transducer. The stylus moves adjacent and parallel to a drum on which the sensitive paper is wrapped, the drum being coupled to the engine shaft to run at the same speed and in accurate index to the engine. Provisions are also made for obtaining top-dead-center and constant-pressure lines on the diagram. Fig. 1 illustrates the afore-mentioned basic elements.

Fig. 2 shows a typical combustion-chamber indicator diagram such as might be recorded by the subject instrument. It will be noticed that at any pressure P, a spark will occur at A when the pickup diaphragm makes contact, and again at B when the contact is broken. For conditions wherein the pressure fluctuates several times each cycle—as is usually the case in exhaust and intake manifolds—the diaphragm will, of course, make and break contact accordingly. It should be noticed that no trace will be plotted if the pressure being studied is absolutely constant—a condition which seldom occurs in engine work.

Instruments of the type under discussion have been available commercially for a number of years. The spark circuits on these instruments, however, are such that it is necessary to make two passes of the stylus; once with the spark circuit set to function when the pickup diaphragm makes contact, and once with the circuit set for break. Since approximately 30 sec are required per pass, a total time of about one minute is required to obtain a card with a sufficient number of spark marks to make a clear line. In some instances it is important to obtain a diagram in a shorter period of time.

[1] Jun. ASME.

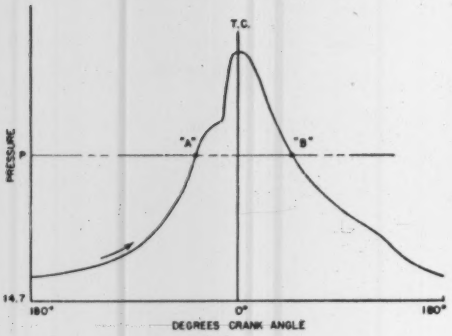


FIG. 2 TYPICAL INDICATOR CARD

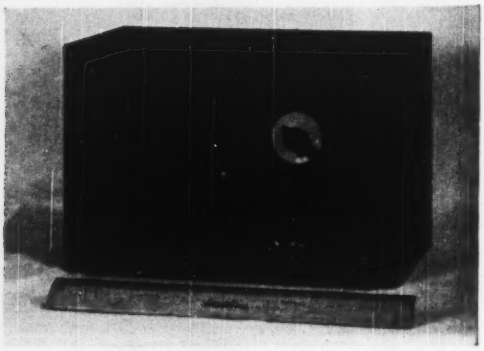
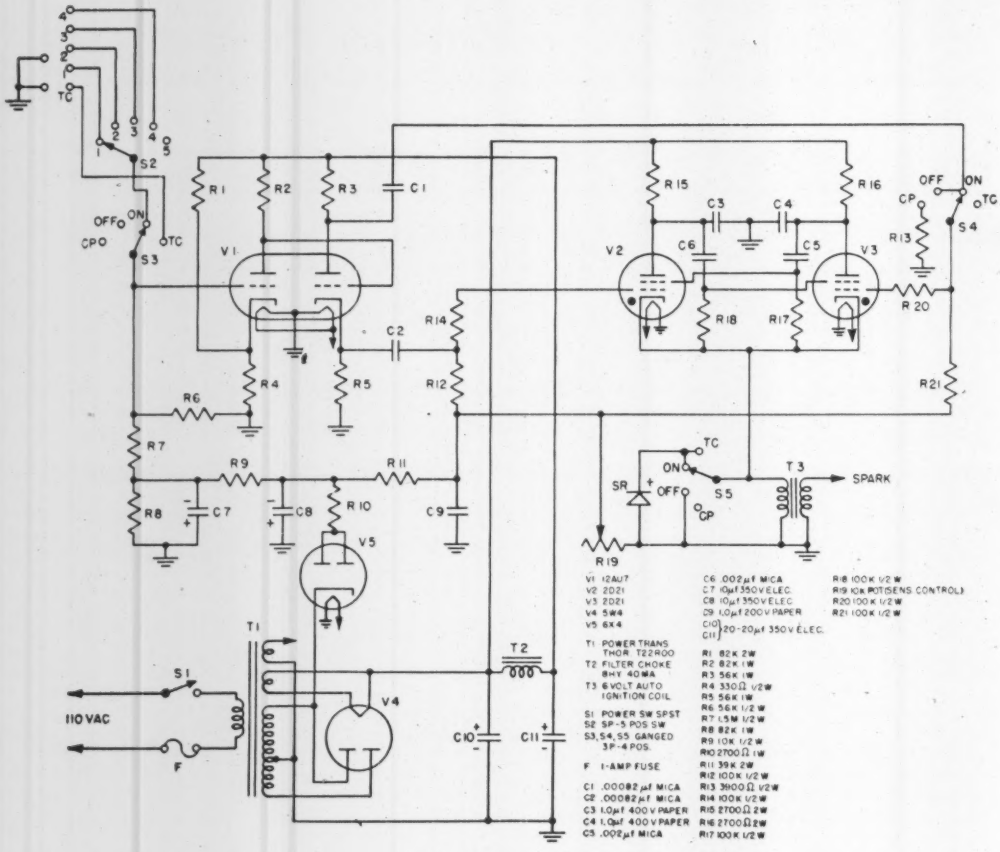


FIG. 4 CIRCUIT CABINET



V1 12AU7
V2 2D21
V3 2D21
V4 5W4
V5 6X4

T1 POWER TRANS THOR T22R00
T2 FILTER CHOKE 8HY 40 MA
T3 6 VOLT AUTO IGNITION COIL

S1 POWER SW SPST
S2 SP-5 POS SW
S3,S4,S5 GANGED 3P-4 POS.

F 1-AMP FUSE

C1 .00082 μf MICA
C2 .00082 μf MICA
C3 1.0 μf 400 V PAPER
C4 1.0 μf 400 V PAPER
C5 .002 μf MICA
C6 .002 μf MICA
C7 10 μf 350 V ELEC.
C8 10 μf 350 V ELEC.
C9 1.0 μf 200 V PAPER
C10, C11 } 20-20 μf 350 V ELEC.

R1 82K 2W
R2 82K 1W
R3 56K 1W
R4 330Ω 1/2W
R5 56K 1W
R6 56K 1/2W
R7 1.5M 1/2W
R8 82K 1W
R9 10K 1/2W
R10 2700Ω 1W
R11 39K 2W
R12 100K 1/2W
R13 3900Ω 1/2W
R14 100K 1/2W
R15 2700Ω 2W
R16 2700Ω 2W
R17 100K 1/2W
R18 100K 1/2W
R19 10K POTSENS. CONTROL
R20 100K 1/2W
R21 100K 1/2W

FIG. 3 CIRCUIT DIAGRAM

In connection with the authors' work, the necessity arose for obtaining cards faster than commercially obtainable balanced-pressure instruments would permit. A new spark circuit, which is the subject of this paper, was therefore developed. The new circuit permits obtaining a diagram with one pass of the stylus, thereby reducing, by approximately one half, the time required to obtain a complete card.

DISCUSSION OF CIRCUIT

Fig. 3 is a schematic diagram of the electronic portion of the indicator. As in a previous model, the spark is produced by the discharge of a condenser through a thyratron and through the spark-transformer primary. However, in this unit two type 2D21 thyratrons are used, one being triggered by the closing of the pickup contacts and the other by the opening of the contacts. The problem that dictated the use of two rather than one thyratron was not the circuit complexities, but the limitations subjected by the recovery time of a single firing condenser. At the peak of an indicator-card diagram, the pickup contact closes and opens again instantly, allowing no time for firing, recovery, and refiring of a single thyratron and condenser.

The potential across the pickup is about 5 volts below the ionization potential of air, and the contact current is less than a milliampere to keep contact burning to a minimum. Since the contact voltage is produced by means of a resistive divider from a much higher voltage, and the signal is led to the grid of an amplifier tube, the source impedance of this contact voltage can be made quite high or low, as desired. With the pickup used in the authors' work, a contact-voltage impedance of 10,000 ohms was found to be most satisfactory. With this value, the open-circuit leakage resistance of the pickup could be as low as 0.2 megohm and the closed-circuit resistance as high as 5000 ohms and still give satisfactory results.

As shown in the schematic diagram, the signal pulses from the pickup are fed to the grid of the triode section of a 12AU7 tube where they are amplified by a factor of about 10, and fed to the grid of the second triode section of the 12AU7 tube. This unit acts as a phase inverter giving two outputs which are mirror images in a phase sense. Resistor and condenser combinations differentiate these signals, converting them to sharp pulses which are applied to the grids of the two thyratrons.

A negative bias of 0 to 50 volts is applied to the grid of the thyratrons by means of a potentiometer control on the instrument. This control serves as a sensitivity adjustment to allow compensation for poor pickup operation. A selenium-type dry rectifier across the spark coil prevents oscillatory discharge which would tend to trigger the second thyratron when the first was fired.

The selection of firing condensers and charging resistors used in this circuit does not allow faster recovery than previous circuits, since the primary purpose of the design was to permit a complete curve to be had from a single pass of the stylus. However, the substitution of a heavier power supply and the insertion of smaller charging resistors would produce quicker recovery and thus allow cards with closely recurring peaks to be taken. The 1-mf condensers charging through 2700-ohm resistances require about 2 millisec to recover, which indicates that peaks nearer together than 12 deg at 1000 rpm cannot be recorded.

The circuit was assembled on a chassis installed in the cabinet shown in Fig. 4. If preferred, the components could be incorporated within the indicator cabinet. Operation of the instrument requires the use of four controls, as follows:

1 On-off switch.

2 Selector switch for use when the signals from more than one pickup are to be recorded.

3 Circuit switch to obtain top-center, atmospheric, standby, and indicator service.

4 Pressure servovalve.

Item (4) is mounted on the indicator proper and has no direct connection with the circuit. The first three switches are mounted on the cabinet panel. A fifth adjustment, the sensitivity control, R16, seldom requires attention and is mounted on the back of the cabinet to avoid accidental maladjustment. The circuit thus assembled was endurance-tested for 10 hr of continuous operation, using a square-wave generator to produce a sparking rate equivalent to 3600 rpm. In addition, it has been used successfully for several hours doing the work for which it was designed.

CONCLUSIONS

The new spark circuit for balanced-pressure engine indicators represents a major improvement for existing and future balanced-pressure-type engine indicators. The basic advantages of the new circuit are as follows:

1 A 50 per cent reduction in the time required to complete a diagram.

2 The contact leakage may be as low as 0.2 megohm.

3 The contact closed-circuit resistance may be as high as 5000 ohms.

4 Actual contact wear is probably less.

Even with the new indicator circuit there will remain occasions, such as studies of cyclic variations, where greater recording speed is required. For these applications, the oscillographic methods of indicating will be required. For the normal applications, however, the circuit which has been described will increase the utility of the balanced-pressure indicator, while at the same time retaining those desirable features of this instrument, such as the ability to maintain calibration and to produce a sizable diagram of accuracy and permanence.

A ONE-ARMED robot on wheels, which can close doors, turn valves, take apart and reassemble complex machinery, and perform virtually every task the human hand can perform, has been developed by the General Electric Company for the Atomic Energy Commission for work in radioactive areas.

The device, known as a "tool dolly," is rolled into radioactive areas where men cannot go, and is operated by remote control from a shielded adjacent room. It moves under its own power along narrow-gage railroad tracks. Power and control are supplied through six cables which lead to the power source and control devices.

The dolly weighs approximately five tons, and resembles a railroad handcar with a small caliber deck gun mounted on it. The gunlike part of the apparatus is a telescoping arm, on the end of which are double clamps, similar to artificial hands used by amputees. The arm can be extended or shortened, raised or lowered, by remote control. The "hand" itself is capable of a wrist-bending motion, rotation, and gripping.

There are six small electric motors in the arm and hand, 24 in the entire unit. In addition to the general-purpose hand, the robot is equipped with a hydraulically driven ram, electrically controlled, which can deliver a four-ton push; rotating devices for opening and closing valves; and several specialized attachments for taking apart or reassembling specific types of machinery. A 3-ft mirror makes observation easier.

The valve-turning attachments are equipped with electric "feelers," which indicate to the operator whether or not the valve handle is properly centered in the grasp of the turner.

COMMUNICATION TECHNIQUES IN LABOR-MANAGEMENT RELATIONS

Their Development and Application

By A. C. CROWNFIELD[1] AND E. S. GRANT[2]

INTRODUCTION

MAN'S progress has always been in relation to the means by which he could disseminate information. Culture and language go hand in hand. As various devices for facilitating communication were successively developed, civilization, as we know it, spread rapidly. Industrialization, however, in the process of creating great wealth and distributing it widely, has formed a society full of mechanical complexities that require large organizations and specialized individuals. In such an economic environment, where man is interdependent yet physically and mentally separate, the difficulties of communication are multiplied manyfold. Despite the wonders science has worked in improving the speed of communication, it has failed on the human side to provide absolutely dependable ways of transmitting ideas from mind to mind. For human broadcasting there is no gadget to measure the adequacy of transmission, the quality of reception or the accuracy of understanding.

Managerial objectives are continually blocked by individual differences in ability not only to transmit but to receive information. Human communication cannot be reduced to mechanics. It is basically an art—the art of making things known through the senses. Its form is determined largely by the nature of our institutions. Its practice is as diverse as man himself. Its effectiveness, however, can be assured by the recognition of certain fundamentals regarding human behavior and relationships, and by the regular use of tried principles and media.

Management's system of communication, whether consciously planned or not, is its life line—the basis of industrial relations. Good leadership means good communication. Just as an army's ability to fight depends to a large extent on the adequacy of its intelligence, so industry's ability to produce is conditioned by its lines of communication within the plant. Weapons do not win wars, and machines do not make goods. In each instance the man power behind them is responsible. And not just numbers of soldiers or workers, but squads and teams of individuals who know what is going on. Without the effective exchange of information, the purposes of any organization become impossible to achieve. Paul Hoffman has defined selling as "the process of transferring a conviction from the mind of the seller into that of the buyer." Substitute "manager" for "seller," and "worker" for "buyer," and the same might be said of production. Thus communication techniques in industry are designed for the sole purpose of accomplishing production—either increasing its rate or maintaining it on schedule—with a minimum expenditure of both human and mechanical energy. In developing and applying these techniques the inseparability of machine from man, of production from personnel, of efficiency from harmony, becomes an axiom.

In this paper the authors wish to limit their discussion of techniques of communication to three relationships: namely, (1) management-foreman, (2) foreman-worker, (3) foreman-steward.

FACTORS IN DEVELOPMENT OF COMMUNICATION TECHNIQUES

The significance of communication in productive profit-making organizations, and the necessity of effective techniques can be understood only if we recognize that a plant is as much a social institution as an economic one. Man at work seeks personal and social as well as economic satisfactions. He is prone to become part of an informal group, which in turn develops a definite pattern of relationships and a particular code of behavior. Each group resembles a family bound together by common loyalties and interests. Departments are homes, aisles and stairways are streets, and the whole plant exists as a community. Superimposed on the formal, company-created organization is a different, dynamic, structure based on sentiments, customs, and cliques. This social structure is not the creation of management yet must be integrated with the technical functions of the plant in order to maintain harmony and efficiency. Ignorance or disregard of such a structure results in management's failure to establish effective communication and, consequently, satisfactory production.

Resistance to change, unionization, slowdowns, and similar negative group reactions are more symptomatic of poor communication than labor-management opposition per se. The manager-technician whose mind is primarily occupied with processes, standards, and controls cannot help but clash with the worker-joiner whose mind is primarily occupied with himself and his friends. Individuals who are made to feel emotionally insecure, or groups that are broken up by the logically determined policies of management, express their dissatisfaction by nonco-operation of one kind or another. That is why management, when introducing technological improvements, must give careful consideration to their social effect on employees. Any change, whatever its anticipated savings, is of value only to the extent of its acceptance and utilization.

One evil consequence of specialization has been that for every specialty there is a different language. Engineers tend to speak in technological terms that sound strange to and con-

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fuse the worker. Management can communicate with the worker only by using words and ideas that are meaningful to him in terms of his experiences and associations. It is the function of the industrial-relations staff and line supervision to act as interpreter and co-ordinator between engineer and worker. Personnel men likewise are susceptible to the virus of specialty jargon and must be vigilant against it. Justice Holmes once said: "A word is not a crystal, transparent and unchanged; it is the skin of a living thought and may vary greatly in color and content according to the circumstances and the time in which it is used." Communication thus requires specialized skill for its purpose just as designing a machine or tool does.

The presence in every plant of both a social and economic organization results in the growth of networks of natural as well as formal human connections. The latter appear clearly on the organization chart as lines of authority. The former are frequently obscure or at least overlooked. A comparison of these two fundamental types of relationships would include the following:

FORMAL RELATIONSHIPS

Between stockholders and directors
Between directors and officers
Between officers and middle management
Between middle management and foreman
Between foreman and workers

NATURAL RELATIONSHIPS

Between management and union
Between foreman and steward
Between union officers and members
Between union members and nonmembers
Between office and factory employees
Between one department and another
Between one group and another
Between one club or activity and another
Between one personality and another

The most serious and difficult problems of communication are found at the bottom of the organization—in the area involving employee, foreman, and their immediate connections. At this level formal and natural relationships overlap and intertwine. Let us examine the structure of the typical department as given in Fig. 1.

From his viewpoint the worker has three close relationships:

1 He deals with management as an employee, in which formal relationship he tries to behave as management expects him to.

2 The worker deals with the union as a member, in which natural relationship he responds to a different set of stimuli, frequently of the emotional variety.

3 He deals with other employees or his group as an individual, usually the strongest of his daily associations.

This third connection is the unseen but omnipresent grapevine—the worker's most natural line of communication, and the most potent of any. Each group has its self-chosen leader, who might be the steward, or—in well-managed departments—the foreman or sometimes neither. Thus management must contend with three lines of communication to reach the worker. Since each line is two-way, up and down, six channels are involved.

Departmental efficiency depends almost wholly on preventing friction between these lines and maintaining an internal balance. To satisfy the needs of company, union, and group, advantage must be taken of each channel. The grapevine is the hardest for management to control but sometimes can be made to work for the company. Lines of communication cannot be strong unless fully used. The very first necessity is to establish, department by department, a friendly environment in which fear is conspicuous by its absence. To build this foundation is a tedious painful task that demands repeated sparking by top management. It requires also the selection and training of enlightened supervisors. Friction usually begins at the department level as the result of neglecting some human detail, or ignoring a single employee complaint. Many times little gripes grow into major grievances because of inadequate leadership, which in turn is due to weak lines of communication. Poor leadership on management's part also tends to render the union's network of communication ineffective. Where both supervisory and union control over a personnel problem is lost, the group takes over. The outcome is usually disharmony and lowered efficiency.

For convenience of classification there are two basic types of communication—the technical and the human. Technical information consists of policies, decisions, instructions, and data which are passed down and up the management channels in order to carry on company operations. Human information consists of similar raw material, but its purpose is employee satisfaction and understanding, and it makes use of union and group as well as management channels. Both types can be broken down into four general forms: namely, verbal, written, pictorial, exemplary. These in turn include the following media:

VERBAL	WRITTEN
Telephone	Advertisements
Public address system	Bulletins
Meetings	Signs
Personal contacts	Forms
	Payroll inserts
PICTORIAL	Letters
Charts	Handbooks
Displays	House organ
Posters	Union contract
Photographs	Grievances
Movies	Suggestions
	Reports
EXEMPLARY	Supervisory manual
Appearances	Booklets
Actions	Attitude surveys

The process of developing techniques from these types, forms, and media of communication should be initiated by the staff organization. Planned techniques work better than those which have sprung up out of sheer necessity. The oper-

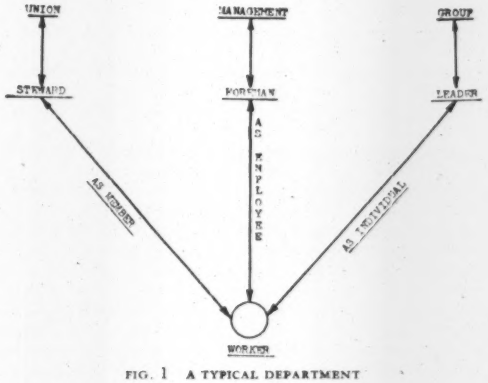

FIG. 1 A TYPICAL DEPARTMENT

ating organization is responsible not only for their success through proper use, but also for their improvement through shared experience. This gradual growth is comparable to the installation of any administrative procedure in that specifications must be laid down and controls set up for their execution. Techniques must be adaptable to sudden changes in company policies or conditions. Specifications and controls, whether technical or human, that are inconsistent or obsolescent, cause serious injury to the lines of communication. Specifications and controls are invalid unless based on current facts.

In regard to written forms of communication, the worst mistake management can make is to use "canned goods." Content and method must be tailored to the conditions prevailing in the shop society and to executive personalities. For instance, because we have a large number of employees who speak and read English poorly, we have posted our factory rules in three languages. The more policies, procedures, and other important company information that can be put down on paper for employees to read, the better. All written materials should be simply, carefully, and attractively prepared. Revision should be made continuously, since nothing is so old—and wrong—as yesterday's truth.

In developing techniques for transmitting technical information, we deal with stable concrete factors in contrast with the variable and often intangible factors on the human side. Technical specifications cover dates and quantities of production schedules, material description and quality, dimensions and tolerances, quality of finish, and detailed instructions for performing the work in conformance with manufacturing standards and customer demands. The giving and receiving of technical information require previous education in the particular kind of production or engineering activity involved. Equally important is experience in how such information should be channeled, in order to insure effective reception and application. The best technical idea in the world is of no value unless it can be transferred in its entirety and put to practical use. Controls for maintaining technical communication include expediting, trouble analysis, inspection—all of which are applied through graphs, memos, direct contacts, or meetings. Good controls depend on intelligently planned and administered systems, trained personnel and constant follow-up. Controls work faster and better if those who handle them aid in their development.

APPLICATION OF COMMUNICATION TECHNIQUES

Management-Foreman. Management endeavors to see that its decisions are passed down the chain of command without distortion, and at the same time to keep abreast of what takes place below. Yet it has been estimated by the U. S. Department of Labor that only about 20 per cent of the meaning of a management message usually gets through to employees via the foreman.

Human techniques for communicating between top management and foremen are naturally conditioned by the particular type of organization and the specific attitudes of management. Good administration requires that a plant be consistently operated in the light of policies founded upon justice and reason—like a code of laws. Also, managerial responsibility, together with adequate authority and proper status, must be decentralized. In this relationship, as in all others, there has to exist a receptive atmosphere before communication techniques can work properly. Such symbols of managerial status as a salary, office, and preferred parking space are essential to convincing the foreman, by deed as well as word, that he is part of management. The foreman wants at all times to be treated differently from the rank and file.

Therefore, the first rule in transmitting information down the formal line is to give the foreman prior consideration. If the employee has a handbook describing company working conditions, the foreman should have a manual that details all company policies and procedures affecting employees. Copies of notices or announcements should be in the hands of foremen at least 24 hours ahead of posting. Before important changes are put into effect, the foremen should be called together to hear the details and reasons. No matter is too small or too big to justify action being taken before the department manager knows about it. Over and over management plans and installs a policy change concerning workers without weighing its possible effect upon foremen. If management persists in viewing foremen and workers as the same audience, the line of communication will inevitably suffer. The downward channel is then obstructed by resentment and indifference; the upward channel simply doesn't work, and management operates in riskful ignorance.

One of the most effective techniques for two-way communication is foreman participation in policy making or changing. Every day the foreman is called upon to make tactical decisions, both human and technical, that for the most part follow standard practices and are subject to little changes and limited interpretation. However, not until he contributes to the making of strategic decisions regarding functions that concern him directly, such as engineering, production or personnel, can he be an enlightened supervisor. Obviously, the more brain power that can be applied to a problem, the wiser the solution is likely to be; certainly, the greater the understanding by all concerned. There are several ways to encourage such participation. For example, before blueprinting changes, the engineering department can save itself future headaches by calling in the department managers involved and soliciting their ideas. Perhaps the production men have nothing better to offer, but by being consulted in advance they will be sold on what's coming through. Consultation can be equally well applied to production scheduling, time studies, job standards, and personnel matters.

The foreman's monthly meeting is also a good opportunity for exchanging important information. Our company believes it is the department manager's duty not only to understand policies but, on the basis of his experience, to help formulate them. Proposals are brought up, discussed, and, if voted, passed up the line for final approval. Rejected proposals are returned with adequate reasons. Once a year, in addition, the foremen's club stages a "management night" at which top management is dined and beered and then politely but firmly put on the spot as to where the foreman stands. This is not so much a gripe session as a valuable chance to consult together.

The practicality of participation may be illustrated by our company's experience with supervisory training. After several years of conducting the usual types of training programs, we suggested to the foremen that they make up and run their own program. They first took a poll which showed a majority preference for a review of personnel policies. With the guidance of the personnel director they chose a conference-type program divided into four groups of seven to eight each. They agreed that the purpose of the conference would be through group thinking to clarify and, if necessary, to recommend changes in existing policies and procedures. It was decided to hold weekly meetings during the early part of the workday when the mind was freshest. Next, five men were selected to undergo a special 40-hr course in the art of conference leadership conducted by the State Department of Education. These leaders then met several times to outline 10 topics of discussion. In the sessions on grievances and merit rating, two other techniques were introduced—the case history and role playing. In each group teams acted out actual grievance cases or merit-

rating interviews. Such demonstrations enabled the good and bad points of handling to be diagnosed and absorbed with a clarity and impact impossible to achieve through the written or spoken word alone.

Out of this conference came 14 recommendations which were screened by the leaders and forwarded to top management. Seven were adopted. In addition, it was evident from the reports that the merit-rating form had serious faults. The leaders, together with the personnel director, devised an entirely new and simpler form which the foremen approved. Until that time merit rating had been accepted with considerable reluctance, but as a result of the group discussions and taking part in the revision of the form, the foremen became convinced of its value as a supervisory tool. In a questionnaire more than two thirds of the participants felt they had a better appreciation of their human responsibilities and personal shortcomings as well as a better understanding of company policies. Altogether, the results indicated that this technique of two-way communication has several outstanding advantages:

1 Under the guidance of a person from the same level of management, a small group promotes the freest and fullest discussion possible.

2 Group thinking, concentrating on one problem at a time, straightens out individual thinking that is "off the beam." Correction by equals is more easily accepted than by superiors.

3 By breaking down specific policies and procedures the group not only unearths the reasons for them but also proves their value to their own satisfaction.

4 Participation—talking together and acting out real situations—enables different personalities to get on the same wave length of communication, so that the knowledge transmitted is clearly received and permanently influences attitudes.

No matter how well done, the written or pictorial is no substitute for the verbal form of communication. Even meetings and conferences are inadequate unless management maintains two-way personal contact with the lower level of supervision, and by example inculcates the company's principles of human relations. Many foremen feel that they cannot get a sympathetic hearing from their superiors. They complain that the only time superiors talk to them is to "bawl them out" for something they have done wrong. Some superiors regard a foreman's effort to communicate upward as interference with their authority. Under such conditions communication is ineffective, and company objectives are thwarted. Foremen cannot be expected to appreciate the human needs of subordinates unless they themselves are treated like human beings rather than organization robots. In his daily face-to-face relationships, the superior must keep the channels of communication open by making the foreman feel secure, by listening, by being careful of how he says and does what he says and does.

Foreman-Worker. In transmitting information directly to employees the foreman depends upon such specifications as company rules, job classifications, and the labor contract. His controls include the reprimand, merit-rating interview, daily contact, and the departmental meeting. Through these controls, employees learn what is expected of them, where they stand and "what the score is" in general. The same principles for accomplishing communication between management and foreman also apply to the foreman-worker relationship. At all times the foreman should try to broadcast on the same wave length that the employee is tuned to, in other words, speak his language and be considerate of his interests.

In any relationship of inequality, as between parent and child or between foreman and worker, conflict is bound to exist. The person on the receiving end of authority tends to feel frustrated, especially if he is denied a voice in his own fate. Management's disregard of this psychological truth has had a great deal to do with employees joining unions, because collective bargaining enabled them to oppose managerial power with equal force and to influence the making of decisions affecting them. The best way to minimize opposition to authority is to encourage employee, group, and even union participation. This is a twofold problem, because on the one hand the foreman must decrease the direct, arbitrary expression of his authority without weakening it, and on the other he must increase the employee's chances to be heard. Obtaining such participation can be done through individual contacts and group meetings, using the informational and suggestion-seeking type of consultation. The department is thus stimulated to work like a team with each member a responsible player who knows the importance of his own place and the goal of the game. Since in this way the channels of communication are kept open and used, the interests of company, union, and group become as nearly integrated as possible.

When several techniques of communication can be combined to accomplish a single objective, they produce a concentrated penetrating effect. For the past two years our personnel department has issued an annual report to employees on their earnings and achievements. This year it was sent in pamphlet form to their homes with a covering letter. Beforehand it was previewed by foremen and stewards. About a week after the mailing, each foreman held a 15-minute meeting of employees in his department. A demonstration by a supervisor of how to conduct such a meeting and a detailed outline had been presented to the foremen ahead of time. The main aims of the departmental sessions were to drive home the information contained in the report, to bring employees up to date about company business conditions, to answer questions arising from the report, and to report employee reactions back to management. Our foremen feel that similar meetings should be held as the need arises to discuss important subjects of general interest.

Foreman-Steward. While the foreman's personal power has in recent years been necessarily lessened by the centralizing of functions and growth of staff services on one side, his position has been further circumscribed on the other by the emergence of a new authority backed by law, namely, the shop steward. It is impossible for the foreman to ignore and disastrous for him to resent the steward. His only alternative is to try to work with him and to get him on the department team. The foremen must show a willingness to understand the union's problems and to consider the union representative an important part of the department organization. Again, this does not mean abandoning the right and duty to manage. It means cooperation and consultation between foreman and steward for the mutual welfare of company and worker. Collective bargaining, even at the department level, cannot function properly unless it is approached as a means of two-way communication based on fact and persuasion rather than sheer force. It involves give and take on both sides, and it demands a peculiar mixture of cold reasoning and human sympathy. In handling grievances it is evident that logical contractual settlements often fail to dispose of problems; the human angle must always be perceived, weighed, and resolved. Being practical is as much a matter of being sympathetic as of being rational. The foreman's attitudes and actions always influence and often determine the steward's reactions. True, the presence of the steward represents a check upon the foreman's freedom. But it also stimulates him to act fairly and wisely with due regard for human factors.

SUMMARY

1 Transmitting information is not as simple as the organization chart might indicate because of the fact that every shop

has social as well as economic characteristics involving multiple and complex relationships.

2 There are two prerequisites to effective communication. One is the understanding of the plant's social structure on the part of top management, and its active steady support of the development and application of communication techniques. Policies must be adopted which fulfill the basic psychological needs of employees and with which management, union and clique can all identify themselves. Instead of regarding the existence of natural departmental work teams as an interference with company organization, management should do everything possible to keep them strong and at the same time to hitch their interests to those of the company.

3 The other prerequisite is the cultivation over a long period of a friendly co-operative atmosphere in which both obligations and rights are recognized, and opinions can be expressed freely and easily. Where negative attitudes of fear or resentment are allowed to prevail, communication is certain to be one way. Only positive communication upward and downward between every important relationship will achieve maximum understanding and confidence.

4 It is a staff function to initiate the policies for technical and human communication, to circulate them, to give service on them, and to follow up their application. Since the operating organization is responsible for executing these policies, it must be adequately trained to transmit the specifications, administer the controls and even help formulate the policies themselves. Poor supervision in any department will quickly short-circuit the networks of communication—especially the management-foreman-employee line. For a supervisor to carry out company objectives, mere technical competence is thus insufficient. A full appreciation of the human element, and the knowledge of how to deal with it, are equally essential.

5 Orthodox communication techniques are entirely too rational and too lacking in emotional personal content. To transmit information effectively, both sender and receiver must be on the same wave length. Man is motivated more by sentiment than by logic. It is futile to communicate solely in terms of the sender's viewpoint. As Roethlisberger has pointed out: "No amount of logical explanation from management's point of view will be emotionally accepted by people if it fails to take into account their personal situations and feelings."[3] It must be remembered that management does not get things done by virtue of its authority alone but by communicating with individuals primarily through day-to-day face-to-face contacts.

6 Education and communication are similar in that both are best achieved through learning by doing. This technique makes use of consultation, personal contacts, group meetings, and joint committees. It is the most efficient way for insuring that information will be understood and that it will be passed upward as well as downward. Collective bargaining alone cannot satisfy the worker's fundamental desire for a say in his economic destiny. The fostering of participation, without sacrificing managerial authority or responsibility, gives employees the feeling of belonging to the company—a necessary precondition to real co-operation.

7 Developing and applying techniques of communication is a slow, experimental, fact-finding task, just like the accomplishment of any technical or scientific goal. It requires skill, patience, and interest. Management must be willing to take extraordinary care that both technical and human information gets transmitted accurately. It must regard the function of communication as an integral part of leadership at every level, not merely as a specialty to be handled by the personnel or public-relations department. It must keep its techniques adjusted to conditions as they are. It can never be satisfied that every workable means of informing is being used and getting results. The extent to which management, through practical communication techniques, can integrate the technical objectives of the enterprise with the human wants of employees will be a major determinant of employee harmony and plant efficiency.

[3] "A 'New Look' for Management," by F. J. Roethlisberger, American Management Association, General Management Series, No. 141, 1948.

Management and Stockholders

MANAGEMENT'S responsibility to stockholders, according to Ferdinand J. Spang, Mem. ASME, lies in safeguarding the property which has been placed in its care and in providing its owners with an equitable and consistent income from it. Mr. Spang, who is president of Spang and Company, Butler, Pa., spoke during the 1949 ASME Fall Meeting at Erie, Pa.

He pointed out that in fulfilling this obligation, management must assume the burden of teaching these owners the basic economics of business so that they understand the climate within which private enterprise can operate successfully, in order that they, themselves, shall not contribute to the destruction of a system which keeps them both economically and physically free.

Management must be continuously aware of the fact that only profits warrant jobs for either men or money. Monopolistic minorities which control economic units of our social structures, who, by force under governmental encouragement for political expediency, extract from the investor and the consuming public disproportionate values for their economic contribution to society are a threat to private enterprise and to our personal freedom, he said. Carried to its extreme, all private capital will withdraw, the government must then produce the services the public will require, forced labor must follow, and freedom will vanish.

Management must not permit the dilution of its authority by those who seek to share its management prerogatives, either in the fields of labor or in the so-called public interest. This, Mr. Spang declared, is an invasion of the inherent property rights upon which our system of private enterprise is founded, and if abandoned can only lead to Stateism.

Management has the full responsibility and obligation to the stockholders to fix the compensation for its top personnel in an amount that is fair to the stockholder and at the same time will attract to or hold in the business the most efficient personnel available for its corporate well being. Block-stock ownership should not be used as a basis of employment or as a means of awarding compensation on any other basis than that which is economically sound and accrues a like benefit to all stockholders. In very simple words, he stated, this means that the employment and compensation of all personnel should be based upon the contribution of the individual to the creation of earnings, and not as a means of distributing them.

Management must be ever aware of the need of forward creative thinking, both of itself and within the framework of its organization. A full realization of changing needs, processes, and procedures, and the adaptation of them to a business is the essence of its growth and service.

In conclusion, he stressed that management's obligation to stockholders is, in addition to that of functional management, that of sharing the responsibility of creating a climate in which private capital shall remain secure and earn a proper wage within the confines of democratic justice to the end that our system of free enterprise shall survive, and that through it ours and other nations shall grow in wisdom and in strength.

WHITHER THE AMERICAN LABOR LEADER?[1]

By JOHN R. COLEMAN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

IT IS a commonplace to say that today's labor leader is a powerful man. Perhaps the atomic physicist alone can challenge him for the honor of having risen fastest to a position of great power. Any current listing of the Americans most influential in shaping the fabric of our society would necessarily contain a generous sprinkling of union executives among the long-established leaders of business, church, army, science, education, and state. It is perhaps surprising then that this newcomer to the ranks of great influence has been so little studied by his contemporaries.

There are any number of sketches of individual leaders, written by enemies and friends alike. A bibliography on John L. Lewis alone would be an imposing document. But for all of these sketches, the good ones and the bad ones, we don't have very much that will help us to answer the key question of where the union leaders would take us with their new-found power. What do the spokesmen for organized labor see as "the better world" toward which they are directing their efforts? How would they have us move toward this brighter day? And what is the impact of their thinking and their actions on the other power centers? All too often answers to these questions have been avoided by the trite claim that labor leaders in this country don't really know where they are going and that their only program is one of grabbing whatever they can from day to day. Such a claim has some truth to it; but, whether they think of the short or the long run, these same leaders have a program in the sense that they envision some sort of redistribution of power among competing groups. The policy makers in the other groups have such programs too, and our progress is a product of the interplay among competing plans. For this reason, it is a matter of immediate concern to all of us to look closely at the men newly clothed in power.

Two recent books[2] offer challenging and penetrating reflections on the programs of union leaders. Each is recommended to anyone who wonders what the emergence of powerful labor leaders portends in this country. These aren't unbiased books. Both of them offer vigorous defense of strong unions. But the biases are clearly evident from the outset, and the reader who is not turned aside by them will find here rewarding reading. One is a background survey of union leadership, with a bold challenge for the future. The other is a foreground study of one of the most dynamic of these leaders, a man who may someday take up that challenge.

C. Wright Mills' "The New Men of Power" purports to be a representative portrait of today's labor leader. Happily it is much more than a portrait in the conventional sense. If one weighs the book on the basis of what it tells, from a series of intensive questionnaires, about the ages, education, background, and attitudes of some five hundred top leaders of American unions, "The New Men of Power" isn't up to much. For the record, Professor Mills' not so surprising survey shows that the average leader in the CIO is, in comparison with his AFL counterpart, younger, better educated, more likely to vote for the Democrats today and for some third party tomorrow, less interested in AFL-CIO unity, slightly lower paid, more convinced of the great power of businessmen in our economy, and more conscious of a "program" guiding labor. But all of these gleanings from Mills' polls have little to do with the main message of the book, and their real value may rest in the fact that they provided the author with an excuse to write the introductory and closing chapters.

Mills is one of that small group of social scientists who turn up from time to time in academic meetings and in the "little magazines" with the express purpose of jolting the complacency of their colleagues. He is the sort of man who, every so often, wants to ask, "Where is our society headed?" The answer which he offers here is, "Into war and slump, unless. . . ." And his "unless" assigns the strategic role to the union leaders. Says Mills: "They lead the only organizations capable of stopping the main drift towards war and slump."

The argument begins with an analysis of the "politically alert publics." Ours is a political society composed of at least six such publics: The far left (the Trotskyites who want labor leaders to mobilize the radical potential of the rank and file); the independent left (the old-time readers of *Partisan Review* and *Politics*, politically a pessimistic group); the communists (for whom the unions are simply instruments in the class struggle); the liberal center (the *New Republic* and *Nation* crowds, who with indignation, hope, and energy are determined to make labor feel at home in their camp); the sophisticated conservatives (those industry leaders who see the unions from a political, manipulative, long-term point of view and who subscribe to *Fortune* and *Business Week*); and the practical right (the pure and simple anti-unionists who enter politics with an economic gleam in their eyes). Mills isn't too much concerned about the noise from this last-named public. But he is very much afraid of the sophisticated conservatives who, tied into the industry-armed forces—State Department axis, are out to lure labor with a liberal rhetoric which has as its key word "co-operation." If labor and the sophisticated conservatives get together, the author sees the United States moving into a corporate form of garrison state. Why? Because labor will have lost its one opportunity to stem the tide toward monopoly and state capitalism. Instead it will have forced the government into the picture as a regulator of big business and big unions.

"The New Men of Power" offers suggested alternatives for the labor leaders. These are dressed in the vague terms which the political left typically handles with so much ease and so little definition: "workers' control over the social process of work," "a running balance sheet of human needs and economic production," and so on. Mills' real contribution does not rest in these alternatives, however. It rests in his interpretation of what he thinks he sees happening in our economy. Maybe he's

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] "The New Men of Power," by C. Wright Mills, Harcourt, Brace and Company, New York, N. Y., 1948; and "The UAW and Walter Reuther," by Irving Howe and B. J. Widick, Random House, Inc., New York, N. Y., 1949.

wrong Maybe there is no danger of a corporate state developing from a rash of union-management co-operation, nor yet from a concentration of monopoly power on both sides of the bargaining table. But unless we can drop the word "maybe" from the foregoing sentence, Mills has done us a service. He has told us that we need to know a great deal more about the consequences of big unions and big management in this country. Moreover he has told the union leaders that this is a late hour to begin preparing themselves for the responsibility which they possess by virtue of their new power. He calls on union leaders to ask themselves where they are going before it is too late.

This book is jolting. It is sometimes ivory-towerish and fuzzy, and its conclusions will not be popular ones. But it does represent an honest—and intellectually challenging—picture of what one man sees when he looks at America's new class of leaders.

In the light of "The New Men of Power," it is of particular interest to examine the program and actions of one leader whom Mills could never charge with run-of-the-mill union thinking. Irving Howe and B. J. Widick have made such an examination in their book, "The UAW and Walter Reuther." There are many who will dispute the authors' contention that they are writing about the most important and interesting union in America. But few will deny that its president is one of the most controversial, imaginative, and powerful leaders of labor.

The Walter Reuther who emerges from this book is a man, like Mills, implicitly rejecting the type of unionism which acquiesces to the capitalist status quo, but, unlike Mills, unwilling to state the rejection openly. Here is a leader to whom an exasperated negotiator for General Motors could say in the heat of the 1945–1946 bargaining sessions, "Why don't you get down to your size and get down to the type of job you are supposed to be doing as a trade-union leader, and talk about money you would like to have for your people and let the labor statesmanship go to hell for a while?" Probably Reuther could promote more industrial peace if he'd forget about looking at the company's books, about telling GM what the price of its automobiles should be, and about such dreams as the one to build factories producing badly needed houses today and, if the occasion arises, fighting aircraft tomorrow. But this isn't the role he has carved out for himself. If Reuther is a statesman, his statesmanship is tempered with restless energy, bold imagination, intense ambition, and political acumen.

However, Howe and Widick are much concerned about the way Reuther may be going. The problem as they see it is that of attaining great power while maintaining broad vision. To some extent the pursuit of power involves some loss of vision, and the authors, who are obviously admirers of Reuther, do not want to see him become another mere opportunist among union leaders. They see dangers in his increasing emphasis upon efficiency and in the increasing distance between leader and followers. "What has happened to Reuther in general," they claim, "is that, to a considerable extent, he has slipped into the character mold of the American managerial type: the personality of neutral efficiency." And the choice before him is presented as that of a "social engineer" manipulating men versus a social leader in close rapport with them.

Howe and Widick's critical appraisal of Reuther is only one of the attractions of this book. A background chapter on "Life in the Factory City" is a brilliant job of reporting on that new sociological phenomenon, Detroit. Against this backdrop there move the figures of tragic Homer Martin, of bumbling R. J. Thomas, and of legendary Henry Ford. A later chapter on the problem of reconciling a union's growth with the maintenance of democracy at the grass roots constitutes a valuable introduction to the politics of any large group. But for all of their considerable merits, these chapters give way to the Reuther portrait in importance. The portrait brings us into a closer appreciation of "our new version of the labor leader: a product of the depression and New Deal eras; a man of unusually broad social interests and intellectual capacities; a former socialist trying to blend recollections of traditional radicalism with a power-conscious appreciation of business and engineering techniques; and a bright young man of the 1930's who, rather than capping the usual socialist flirtation with the usual New Deal job, chose to work his way up in the CIO."

Whither the American labor leader? Reuther's career presents an interesting answer to our question. There will always be intellectuals outside of the labor movement—men such as Mills—who offer to labor a philosophy to guide its actions. There is little immediate likelihood that labor will pick up any such philosophy wholesale. But probably there will also be leaders of the Reuther variety who seek out a compromise between what he finds good in the intellectuals' program and what he finds attainable in the collective-bargaining and political spheres.

This means that, on the one hand, we will see a great deal more of unionism of the catch-as-catch-can variety. But it means too that, on the other hand, there will be constant underlying pressures from the unions to change the shape of our society. How important those pressures become at any moment would seem to turn on how one answers the question which Howe and Widick pose for us, "Can a labor leader have both power and vision at the same time?"

A MANUFACTURING method which is claimed to increase the quality and uniformity of man-made cold rubber and improve the efficiency of the process is being used by B. F. Goodrich Chemical Company at Port Neches, Texas, it was revealed recently.

The method is reported to be one of continuous processing and gives greater uniformity in quality of the longer-wearing cold rubber than was possible under the batch system heretofore used.

The Port Neches plant is currently turning out cold rubber at the rate of approximately 30,000 tons annually for the government. This is slightly more than half the plant's present total output.

The cold-rubber-production unit has two series of 3700-gal reactor tanks, 12 tanks to the series. In the "continuous processing" system, butadiene, styrene, water, soap, modifier, and catalyst are pumped continuously into the first reactor tank, then into the second, and so on right down the line to the twelfth reactor tank, at which time the butadiene and styrene have been polymerized satisfactorily to form cold rubber as a latex.

The latex, which is continuously discharged from the last reactor tank, is then pumped into other sections of the plant where it is coagulated, dried, and made ready for shipment.

This system, it was indicated, makes it easier to maintain stable 41-deg temperatures during polymerization.

Under the batch-processing technique formerly used by the company the principal ingredients of American-made rubber were pumped into each of the 12 reactor tanks in the production series. After mixing and polymerization each batch would be dicharged from the reactor into blowdown tanks for further processing. Each batch had to be laboratory-checked and temperatures had to be watched constantly for fluctuation. It was pointed out that the continuous filling and emptying on an individual basis not only tied up man power but was time-consuming.

ENGINEERS JOINT COUNCIL

THE Engineers Joint Council is a voluntary association of engineering societies organized to promote co-operation among the various branches of the engineering profession and to participate in the formulation of sound public policy in national and international affairs wherein the engineering profession has competence. It is composed of the following Societies: American Society of Civil Engineers; American Institute of Mining and Metallurgical Engineers; The American Society of Mechanical Engineers; American Institute of Electrical Engineers; and the American Institute of Chemical Engineers.

EJC HISTORY

EJC evolved from an awareness among engineers that the engineering profession has a social responsibility which can best be fulfilled through co-ordinated planning and unified action by the major engineering societies. The roots of the EJC go back to 1920, when, under the leadership of Herbert Hoover, The Federated American Engineering Societies, later known as the American Engineering Council, was established to crystallize engineering thinking on problems of national and international nature as an aid to legislators and other interested groups. One of AEC's monumental achievements was its report "Waste in Industry" which was republished in most of the industrial nations of the world, and at home did so much to make American industry conscious of the cost of waste and the techniques of waste reduction.

More directly, EJC stems from the Joint Conference Committee made up of the presidents in office and the secretaries of the Founder Societies, which was established in October, 1941, to consider some of the common problems facing the engineering societies. The following year AIChE was invited to join the Committee. During the war years the Committee served the Government as the Engineers Defense Board and contributed much to war production by suggesting substitute materials and methods for economizing and salvaging scarce war materials. In 1945 the Committee changed its name to the Engineers Joint Council, and it was as the EJC that the Committee issued its reports on the Industrial Disarmament of Aggressor States which were warmly acclaimed by the Allied authorities.

As the EJC began to take up the postwar problems of the profession, it became evident that the informal nature of the Council was inadequate for the business at hand. In 1949 a formal constitution was ratified by all member societies. The streamlined structure of this constitution resulted in reducing the work load on individual members of the Council, and provided for admission of new members.

EJC OBJECTIVES

In the language of its constitution, the EJC has three objectives: (1) To advance the general welfare of mankind through the available resources and creative ability of the engineering profession; (2) to promote co-operation among the various branches of the engineering profession; and (3) to develop sound public policies respecting national and international affairs where the engineering profession can be helpful through the services of the members of the engineering profession.

Implied in these objectives is the ideal of a profession—that of administration to the public need; of co-operation among engineering societies as an essential ingredient of the professional spirit; and of public service as the proper path to economic and social status for the engineer.

To achieve these objectives, the constitution directs the Council: (1) To act as an advisory and co-ordinating agency to seek out and study matters of mutual interest to the constituent societies of the Council and to recommend parallel action by them; (2) to represent the constituent societies of the Council in instances in which those societies deem such joint representation to be desirable; and (3) to administer, on behalf of the engineering profession, those activities authorized by a majority of the societies represented on the Council.

HOW EJC FUNCTIONS

Engineers Joint Council is composed of 25 representatives, approved by the engineering societies. Fifteen are voting members; five are official alternates who vote only when substituting for a voting member; and five are ex-officio members who are the presidents in office of the five constituent societies. Each society therefore has five representatives on the Council, three of whom have a vote. The voting members are the two most available past-presidents and the secretary of each society. Alternate members are chosen from the governing board or council of each society. It is apparent from this structure that the Council represents a concentration of experience and ability, which coupled with a devotion and loyalty to the profession, results in caution and mature judgment.

As its name implies the Council is a deliberative and co-ordinating body. Its projects are carried out by working committees composed of members of the constituent societies who are qualified to undertake the task at hand. At the present time the Council has 15 standing committees. From time to time as many as 150 members of the constituent societies are working on EJC projects.

EJC standing committees are: Committee on Constitution and By-Laws; General Survey Committee; Unity of the Engineering Profession; Labor Legislation Panel; Science Legislation Panel: Engineers Co-operating in Medical Research; Engineers in Civil Service; Selective Service; National Water Policy; Fuel Resources; National Engineers Committee; and International Relations. EJC also has a representative on the U. S. Commission for UNESCO and a liaison representative to the United Nations. For its working members, EJC calls upon qualified members of its constituent societies and co-operates with other engineering groups who can contribute to the specific problems under consideration.

The Council meets usually on the third Friday of the odd-numbered months. Meetings are held in the Engineering Societies Building, New York, N. Y. The meetings are open and members of the societies are invited to attend them. During the interim periods, an executive committee, composed of the president of the Council and a recent past-president of each constituent society, conducts EJC business.

The voluntary nature of the Council is apparent from the provisions in the constitution for financing its operation and for terminating membership. Each society is asked to pay its share of the operating expenses which are prorated on the basis of the percentage of the dues each society receives. No member society is asked to contribute to any EJC project of which it does not approve. For example, if only three of the member societies vote for a project, it becomes an official EJC operation, but the cost of the project is met not by assessing each of the five member societies but only the three which voted for it.

Any engineering organization whose members constitute a

(Continued on page 402)

WHAT IS ECPD?

THE Engineers' Council for Professional Development, organized on October 3, 1932, is a conference body which functions as a co-operating agency for the following eight national engineering organizations:[1] American Society of Civil Engineers, membership, 27,649; American Institute of Mining and Metallurgical Engineers, membership, 16,130; The American Society of Mechanical Engineers, membership, 31,389; American Institute of Electrical Engineers, membership, 33,822; The Engineering Institute of Canada, membership, 12,282; American Society for Engineering Education, institutional membership, 175; individual membership, 6700; American Institute of Chemical Engineers, membership, 9786; and the National Council of State Boards of Engineering Examiners, membership: 51 member boards, 293 legally appointed board members, reporting approximately 155,000 legally registered or licensed engineers.

ECPD is not an independent body but derives financial and personnel support and administrative personnel from constituent organizations. ECPD functions are promotional and exploratory. Its responsibility is the professional welfare of the individual engineer regardless of his specialized technical field.

HOW IS ECPD ORGANIZED?

The governing body of ECPD is a council composed of 24 voting members, three from each sponsoring organization, and four ex-officio members who represent the four main ECPD Committees on Student Selection and Guidance, Engineering Schools, Professional Training, and Professional Recognition. The Council has two main functions: It explores professional questions and makes recommendations. ECPD recommendations go to the governing boards of sponsoring organizations which act on recommendations and administer recommended procedures through their own national and local groups.

For practical purposes the ECPD business is carried on by an Executive Committee composed of eight voting members, one from each sponsor society, and four ex-officio members. The Executive Committee usually meets about six times a year in the Engineering Societies Building, New York, N. Y., where ECPD maintains its headquarters. The Council meets once a year, in various cities, at an ECPD Annual Meeting in October.

The Council has six committees: Two special committees, one on Information, the other on Principles of Engineering Ethics; and four standing committees which are responsible for the four main ECPD activities: Student Selection and Guidance; Engineering Schools; Professional Training, and Professional Recognition, which cover all the stages of professional growth of the individual.

However, its policies and recommendations can become effective only as they are approved and adopted by the constituent organizations and put into effect on the firing line in communities where boys need guidance in the selection of a career; in the engineering colleges where high quality of instruction must be maintained, and in every part of the continent where engineering graduates find their employment and become members of the profession and where the need exists of raising the economic status and professional and public recognition of the individual engineer and the engineering profession. The responsibility for the success of the ECPD program therefore rests on every engineer, as well as on the constituent societies.

WHAT IS ECPD TRYING TO DO?

One of the basic ECPD concepts is that there are four normal stages in the life of the engineer, in each of which the engineering profession has a responsibility. In the first or precollege stage, the profession must see that only those who are fully qualified should embark on the arduous course of engineering studies. In the second stage, that of undergraduate study, the profession must share with the colleges the responsibility for standards of engineering instruction. In the third stage, which begins when the young engineer enters industry, the profession must create the opportunities for further personal and professional growth; and in the fourth stage of full professional practice the profession must concern itself with the legal and professional standards by which the engineer becomes established and recognized.

The ECPD Charter creates a standing committee charged with responsibility for each of the four stages. They are:

Student Selection and Guidance. The Committee on Student Selection and Guidance concerns itself with aspirants to the engineering profession. It helps them by providing means for educational and vocational orientation with respect to the responsibilities and opportunities of the profession. It tries to assure that only those having the personal qualities, aptitudes, and capacities required of engineers will actually seek entrance to the profession through engineering schools. Attainment of the committee's objectives involve:

1 The supplying of information to each student or potential student concerning the qualifications essential for success in the profession of engineering.

2 Preparation of a battery of examinations called the "Pre-Engineering Inventory," designed to determine the aptitudes of students who are considering engineering studies. Administration of these examinations has been taken over by the College Entrance Examination Board.

3 Continuing assistance to the various local engineering groups and other agencies which guide high school students in the selection of first-year college curricula.

4 The guidance of individual engineering students in the selection of those engineering courses best suited to their individual talents through continuing tests of student attainment.

5 Stimulation of a more active participation of the local organization of ECPD constituent societies in the active promotion of ECPD objectives at the community level.

Engineering Schools. The objective of the Committee on Engineering Schools is the establishment and maintenance of an appraisal of engineering curricula in colleges throughout the United States and the preparation of an authoritative list of accredited engineering curricula available to state licensing boards, the engineering profession, educational institutions, prospective students, and the general public. The accomplishment of this continuing objective involves:

1 The examination and evaluation of new engineering curricula.

2 Periodic reinspection and re-evaluation of previously accredited undergraduate engineering curricula, to guarantee that minimum standards currently are being met.

3 An extensive program of inspection and evaluation of technical institutes.

4 Study leading to the possible inspection and accrediting of graduate courses in engineering.

5 Study leading to the possible extension of the undergraduate inspection and accrediting program to South American engineering colleges.

[1] Figures are as of December 1, 1949, except for NCSBEE.

6 Consideration of the question of minimum standards of basic engineering content in engineering curricula.

Professional Training. The Committee on Professional Training was formed to develop plans to further personal and professional development of young engineering graduates. Attainment of these objectives involves:

1 The stimulation of postcollege training programs within industry that will correlate the interests of engineers with those of management, thereby enabling each young engineer to develop his professional potentialities more rapidly and effectively.

2 Encouragement of the young "engineer in training" to complete the requirements for an engineering license or legal registration; in general, the stimulation of an individual study program to aid the young graduate to avoid "postcollege slump" in his personal technical development, emphasizing the factors needed for promotion to positions of greater professional responsibility.

3 The preparation and distribution of the ECPD manual, "A Professional Guide for Junior Engineers," which is intended to serve as a guide and stimulation for the engineer during the years immediately following his graduation.

4 The encouragement of engineering graduates to participate in the activities of the local sections and chapters of ECPD's constituent national engineering societies, and thus to avail themselves of the opportunity to meet regularly with older engineers for the discussion of problems of common interest, as well as for the cultivation of congenial social relationships.

5 The development of detailed practical programs to stimulate the furtherance of ECPD objectives through the medium of local engineering groups and local units of the national societies.

Professional Recognition. The Committee on Professional Recognition is concerned with the more mature engineer of some practical achievement. It endeavors to develop methods whereby each individual may achieve appropriate recognition by the profession and by the general public. Attainment of these objectives involves:

1 Development and promulgation of clear definitions of the function of each type of professional man entitled to call himself an "engineer," and the maintenance of a clear distinction between professional and nonprofessional services.

2 The development of a better understanding of the role of the engineer in modern society, and the promotion of a healthy pride in engineering achievements among engineers themselves. The engineer traditionally is overmodest.

3 The development of methods whereby ECPD can help engineers become an arm of management in industry, to improve labor relations and individual productivity.

4 The development of a professional consciousness among engineers, engineering teachers, and engineering students.

5 The working out of a detailed program for professional unity. The promotion of uniform membership grades and nomenclature in the national engineering societies. Study of the possible need for an over-all engineering society or federation.

WHAT HAS ECPD ACCOMPLISHED?

Student Selection: In the field of student selection and guidance and engineering schools, ECPD has achieved notable success. Through its Committee on Student Selection and Guidance, ECPD was the cosponsor, with The Carnegie Foundation for the Advancement of Teaching and The American Society for Engineering Education, of two widely used aptitude tests of value to students contemplating careers in engineering. In 1947–1948 more than 20,000 students took the tests. In 1948, administration of the tests was turned over to the newly organized Educational Testing Service, with headquarters in Princeton, New Jersey. Also, more than 125,000 copies of the committee's booklet, "Engineering as a Career" have been sold. Posters on the same topic have been distributed among 5000 high schools.

Engineering Schools: Perhaps the most conspicuous of ECPD's accomplishments is its program of accrediting of engineering curricula conducted by its Committee on Engineering Schools, in fulfillment of its original assignment "to formulate criteria for colleges of engineering which will insure to their graduates a sound educational background for practicing the engineering profession." As of October, 1948, some 688 curricula had been inspected, evaluated, and 592 accredited at 137 degree-granting institutions, in the United States; 86 of the curricula examined were not accredited. Twenty-three curricula had been accredited at 13 technical institutes in an initial extension of the accrediting program to this type of training.

Professional Training: ECPD achievements in the field of professional training and professional recognition are more difficult to evaluate. Here future progress has its greatest opportunity. More engineering schools are sponsoring evening classes on the graduate level and more graduate engineers are finding it possible to continue their engineering studies while making the adjustments imposed by life in industry. The ECPD program has also won the support of many employers of engineers who are assuming responsibility for training opportunities of their staff engineers. Much, however, remains to be done, especially for engineers in the smaller communities. ECPD recently published "A Professional Guide for Junior Engineers," to aid the junior engineer in finding his place in the profession.

Professional Recognition: In the field of professional recognition the ECPD task has been to establish recognized measures of performance to serve as certification of full professional status. Membership in a professional society and a license to practice engineering are currently serving this purpose, but before these steps are fully effective much must be done to establish definitions and standard membership labels and state registration laws.

Unification of the Profession: By focusing the thinking of engineering societies on matters of common professional concern, ECPD has been setting the stage for eventual unification of the engineering profession. It has provided opportunity for leaders of the various branches of engineering to work together. This backlog of experience is contributing to the success of the Engineers Joint Council, the agency through which the Founder Societies (ASCE, AIME, ASME, and AIEE) and the AIChE work together on matters of economic import for engineers. Where ECPD is concerned with the individual welfare of engineers, the EJC is organized to represent the engineering profession in matters relating to sister professions, international relations, and government agencies.

YOU CAN HELP

There is ECPD work to be done in every industrial community. ECPD activities on the national level must be organized as community projects. If engineering is to continue as a proud and respected profession, individual engineers must contribute imagination and energy to maintaining high standards of engineering performance. With respect to the four cardinal tasks of the ECPD, the first question each engineer should ask himself is, "Why should I not help?"

Here are some of the jobs to be undertaken:

1 Help to organize a local ECPD student guidance commit-

tee to co-operate with high-school authorities in the job of helping boys in selecting a career. ECPD groups should talk to graduating students, explain the nature of engineering work and the qualities which bring success in it.

2 Organize ECPD groups to study industry training programs, encourage co-operative evening study programs, and exchange facilities. There is no reason why engineering staffs of one company should not support city-wide training programs co-ordinated with state engineering registration requirements and sponsored by local industry and engineering schools.

3 Organize ECPD groups to study state engineering registration laws with the objective of encouraging greater uniformity among the states. Local ECPD committees must assume responsibility of evolving registration machinery which can become an important measure of professional recognition.

Engineers Joint Council

(*Continued from page 399*)

generally recognized branch or group of the engineering profession is eligible for membership. Admission requires not less than a two-thirds affirmative vote of member organization. A society can resign from the Council simply by giving a 90-day written notice of its intention.

EJC ACTIVITIES

EJC is doing numerous things for the individual engineer and his profession to justify his support of its operation.

Economic Trends. The EJC keeps in touch with and reports on conditions within the profession. In 1949 its General Survey Committee's report on "1949 Employment Programs for Engineering Graduates" assured hosts of new graduate engineers of a continuing demand by employers for young engineers, and provided data on salary trends. EJC is working on a similar survey covering 1950. As conditions change and new facts are needed, EJC has the machinery to sound out the profession, quickly and economically.

Unified Profession. One of the basic premises of the EJC is that if the engineering profession is to contribute to policy decisions in high places, engineering societies must act together on common problems. After many years of fact finding and study, EJC is sponsoring a series of conferences attended by representatives of 16 national engineering societies toward increasing the unity of the engineering profession. Several plans have been proposed and are now under discussion.

Labor Legislation. EJC is alert to moves to disregard the professional status of engineers. When the Taft-Hartley Law was under consideration by a Congressional committee, EJC appointed a Labor Legislation Panel which included also representatives of the American Society for Engineering Education and the National Society of Professional Engineers. The Panel presented testimony evidencing the right of engineers as professional employees to select their own bargaining agents or to refrain from collective bargaining.

Science Legislation. EJC has been interested in the National Science Foundation Bill as it affects the engineering profession. As originally presented, the Bill made no provision for engineering or engineering research. The EJC Science Legislation Panel was successful in correcting this omission in a resubmission of the Bill. After the Senate passed a bill, a slightly different version was passed by the House. The matter is now in the hands of a joint committee.

Medical Research. EJC has taken the initiative to bring engineers in contact with research activities in the medical sciences which are often retarded because of difficult engineering problems. In 1950 the EJC Committee of Engineers Co-Operating in Medical Research called a conference attended by a large number of engineers and members of the medical profession at the Cornell University Medical College. The Committee hopes to develop a successful pattern of co-operation between the two professions, first in the New York area and eventually elsewhere.

Civil Service. The professional engineer in civil service sometimes finds that the Civil Service Commission does not recognize his professional status. EJC has recognized this situation and is working to establish an Engineers Advisory Committee to the U. S. Civil Service Commission which can act for the professional engineer when problems arise from Civil Service regulations.

Selective Service. Concerned about indiscriminate drafting of engineers in World War II, EJC created a Selective Service Committee to work with the National Advisory Committee on Selective Service.

National Water Policy. For several years EJC has been working on a comprehensive national water policy. President Truman has recognized the problem and appointed the Water Resources Commission. The facilities of EJC have been made available to the Commission. Comprehensive reports are currently being written which incorporate the recommendations of the profession on engineering aspects of a national water policy.

National Engineers Committee. Since 1944 EJC has had a Committee working with various government bureaus and agencies on matters of an engineering nature. For the Economic Co-operation Administration, EJC helped in the selection of engineering personnel for ECA European offices. For the Office of Naval Research, EJC conducted a survey to obtain data for a source file of key engineers in research and development work. For the U. S. Army, EJC established a Task Group on Military Classification which consists of two members from each EJC Society to develop standard job classifications.

International Relations. Through the activities of its Committee on International Relations, the name of Engineers Joint Council has been made synonymous with the American engineering profession for most engineers overseas. EJC readily accepts responsibility for organizing United States participation in international engineering congresses. In the past EJC has contributed to the world technical congresses of the World Engineering Conference, the first Pan American Engineering Congress, and the conferences of the Engineering Societies of Western Europe and the United States.

To replace engineering books in the war-devastated libraries of Europe and Asia, the EJC sponsored a book campaign during which U. S. engineers donated nearly 100,000 items of engineering literature. EJC was invited by the State Department, to appoint a representative on the U. S. Commission for UNESCO. The Commission consists of 100 individuals representing various aspects of American culture and life. Its task is to advise the U. S. delegation to UNESCO (United Nations Educational, Scientific, and Cultural Organization).

More recently EJC applied for consultative status with the Economic and Social Council of the United Nations.

From its diversified activities during the last several years in behalf of the engineering profession in national and international affairs, EJC has accumulated a fund of experience in united action, and has demonstrated its ability to crystallize engineering thinking on professional matters and to stimulate united decisions on common objectives. Today EJC is available to all who would use it for the betterment and advancement of the profession.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Compiled and Edited by J. J. Jaklitsch, Jr.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Industrial Dispersion

THE problems involved in the strategic location and relocation of industries, which is essential to the nation's security, are discussed in a booklet issued recently by the National Security Resources Board, Washington, D. C.

The purpose of the booklet is (1) to alert industrial leaders to the strategic significance of industrial-plant location in the event of another war; (2) to suggest that industrial leaders think of strategic location or relocation of plant facilities as an added essential factor in any plans for plant expansion; and (3) to impress upon industrial leaders the urgency for this type of thinking. Urgency, not because a national emergency is necessarily imminent, but because 12 to 14 billions of dollars are being spent annually for new plants and new equipment. A substantial portion of these plants being located in highly concentrated industrial areas, thereby increasing vulnerability in the event of attack.

The constantly increasing range of aircraft, together with the enormous destructive capacity of atomic weapons, makes it reasonable to assume that within the foreseeable future no area in the United States will be immune from possible attack because of its location alone. This assumption, coupled with the knowledge that the destruction or immobilization of a nation's vital industry will destroy its capacity to defend itself, makes it reasonable to assume that highly concentrated areas of vital industry and population will be the most attractive targets, the booklet states.

It is pointed out that dispersion of industry will go a long way toward combating a potential enemy's effort to cripple our industrial capacity by any mode of attack, conventional or otherwise. The security provided by industrial dispersion becomes more apparent when we measure the significance of modern strategy in terms of its possible application by a potential enemy.

The scarcity of the essential materials for the manufacture of an atomic bomb makes production so costly that we may reasonably assume that no country in the foreseeable future will ever have enough to afford to use one on each city of as few as 50,000 people, or on a congested industrial area of less than five square miles.

Atomic bombs exploded to date have destroyed almost everything within a one-half-mile radius of the zero point. Beyond the periphery of this first area, and extending to a distance of about one and one-half miles, they caused moderate damage to all structures. Allowing for future developments, it is not expected that an improved bomb would cause heavy damage beyond a distance of three miles from point of detonation.

Studies made to date indicate that areas of industry concentration less than five square miles, or urban concentrations of less than 50,000 people, separated by about 10 miles of relatively open country, will be reasonably secure from attack under all circumstances expected to prevail. These factors may be employed as a yardstick in evaluating prospective sites, although, admittedly, such thumb rules tend to oversimplify the problem.

Among other things, thinking should be projected in terms of the probable growth or foreseeable developments in the prospective area which might make it strategically vulnerable. It should also be borne in mind that the location of one industry in a community normally influences growth of other dependent or allied industries and services. General trends in population movement must also be given proper weight.

In this connection, topographical features of terrain become significant. In World War II, Hiroshima and Nagasaki were chosen as targets for the atomic bomb because of their strategic concentration of industrial activities. Deaths in Nagasaki, however, despite its greater population density, were only one half those of Hiroshima. Topography was the major factor in accounting for this difference. Ridges of hills separated areas of Nagasaki into dispersed built-up pockets, whereas Hiroshima was relatively flat and uniformly concentrated. The Nagasaki bomb thus dissipated much of its energy against hills and unoccupied areas, while the Hiroshima bomb achieved its most devastating effect.

Industry fared better in Hiroshima. All major factories were reasonably well dispersed and escaped serious damage. At Nagasaki, plants and dockyards at the southern end of the city were left intact, but those concentrated in the valley where the bomb exploded were almost completely destroyed.

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

It is fully recognized, of course, that a fundamental requirement in any survey of an area for selection of a location is that it be economically feasible to the particular industry concerned. With few exceptions, however, economic advantage and relative strategic safety will not be incompatible.

Some of the basic factors governing the economic evaluation of plant location are as follows: Location of production materials, labor, sites, industrial fuel, transportation facilities, market, distribution facilities, power and water, living conditions, laws and regulations, tax structure, and climate.

When a comprehensive survey of prospective locations has been made, it is probable that several will be found to be economically practical. The problem then becomes one of selecting the location which is strategically most desirable.

The National Industrial Conference Board in its study, "Decentralization of Industry," states:

"There is a trend toward locating manufacturing plants in the smaller cities and towns. Cities and towns with 10,000 to 100,000 population are reported to be the most popular places for plants established from 1940–1947. Only one third of the plants built or acquired since 1940 are in cities of 100,000 and over. For plants established prior to 1940, close to half were in cities of that size. On the other hand, almost 30 per cent of the plants established since 1940 are in towns of 10,000 or less, against only 20 per cent of the plants built before 1940."

If the industrial facilities of the United States were effectively dispersed, that fact alone would make an incalculable contribution toward the maintenance of peace because of the prohibitive expense of any enemy attempt to destroy this country's ability to defend itself. Dispersion could contribute significantly toward outlawing war.

High-Compression Engines

THE redesign of the traditional automobile engine is long overdue, writes Alex Taub in the February, 1950, issue of the *Scientific American*. According to Mr. Taub, consulting engineer to the automotive industry, such changes are necessary and are generally recognized in the industry.

He points out that the auto industry's new engines must be designed to burn less gasoline per mile. On this objective all participants in the controversy agree. They agree also that the best single way to improve the efficiency of our auto engines is to increase the compression ratio. A step up in the compression ratio from the present 7-to-1 standard to 12-to-1 would reduce the consumption of fuel per auto by 33 to 40 per cent.

The heart of the issue is how this high compression is to be made feasible—whether it shall be by the use of high-octane fuel or by basic changes in engine design. The automobile industry proposes to control detonation in the new high-compression engines by using higher-octane gasolines. This would permit the achievement of high compression with minimum changes in engine design. On the other hand, the fuel industry and its engineers, seconded by many automotive engineers, believe that detonation should be controlled by changes in engine design. Detonation control should be built into the combustion chamber of the engine, not into the fuel. High-compression engines not only can be but have been built to operate successfully on standard octane rating fuels. In Europe, where fuel is less abundant and less cheap than in the U. S., this is the accepted approach to the control of detonation. Nondetonating engines would place far less demand upon our fuel resources than nondetonating fuels, and would yield cheaper as well as more miles per gallon.

Four such high-compression engines, which have operated successfully on standard-octane-rating fuels, were described by Mr. Taub in the article. Three of these, the single-sleeve valve, the split-sleeve valve, and the rotating-chamber designs, would be too radical by Detroit standards and too costly to provide an early solution to the problem, he says.

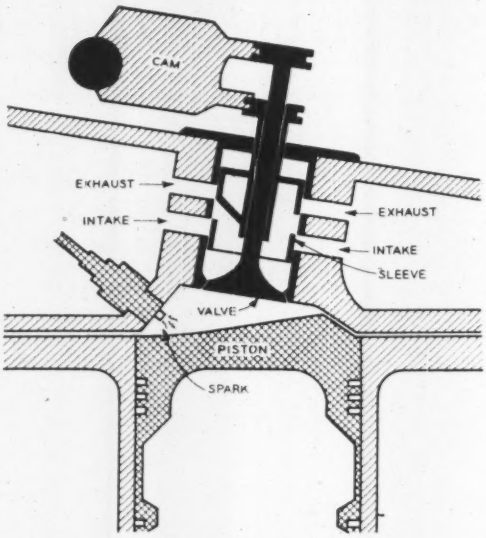

FIG. 1 SINGLE-VALVE ENGINE

The fourth type, however, the single-valve engine proposed by Rollin Abell of Boston, in 1914, represents an engine closer to familiar designs and well within the range of present manufacturing costs.

In this design the single valve opens the combustion chamber to both the intake and the exhaust manifolds. The manifolds in turn are opened separately by a sleeve which is concentric with the valve stem but is driven by an eccentric cam, different from the cam that drives the valve. The sleeve does not require snug fitting; it need fit no closer than 0.006 in. During the crankshaft's two complete rotations in each cycle, the single valve is heated by the exhaust for 220 deg of rotation, is cooled for 220 deg by the inflowing fuel, and for the remaining 280 deg is on its seat, cut off from the exhaust manifold by the sleeve for most of this time. Thus with the single-valve engine we have the advantages of direct cooling by the fuel and a minimum flowback of heat from the exhaust manifold.

This is a simple and effective way to get rid of the red-hot exhaust valve, which in many conventional engines operates at temperatures of 1700 F, and thereby to achieve mechanical control of detonation at high compression ratios. Exhaustive study indicates that the lowered temperature of the single valve represents a gain in antidetonation value equivalent to 25 to 30 octane. Assuming the gain to be only 20 octane, this means that the engine would perform as well on 65-octane as present engines do on 85-octane fuels, states Mr. Taub. We could be certain of a 10-to-1 compression ratio with 78 to 84-octane fuel. With a 92-octane fuel we could expect this engine to climb to a 14-to-1 compression ratio.

According to the article, the single-valve design has other advantages that promise economies over and above those obtained by the high compression. In any engine the lowest

consumption of fuel is determined by the leanest mixture that will burn. The single-valve engine will operate on very lean mixtures without missing. Moreover, at full throttle, present engines depend upon increased wetness of the fuel to provide internal cooling, particularly of such hot spots as the exhaust valve. The single-valve engine operates on a leaner full-throttle mixture and thus eliminates the use of fuel as an internal fire extinguisher. These economies, plus the savings inherent in high compression, indicate an over-all reduction of 50 per cent on the consumption of fuel per automotive unit. Multiplied by the number of vehicles on the road, they equal a saving of 400 million barrels of fuel per year. Converted into dollars at present wholesale gasoline prices, this comes to $1 billion per year. In other words, the fuel saving that can be achieved in a single year by newly designed nondetonating engines is five times the cost of completely retooling our engine lines.

Diesel-Lubrication Tests

OIL maintenance and purification problems encountered on the Diesel test floor of Fairbanks, Morse and Company, Beloit, Wis., were outlined and discussed by E. L. Conn, staff assistant to general manager, and T. M. Robie, Mem. ASME, manager of quality control, Fairbanks, Morse and Company, at the 1949 ASME Annual Meeting held in New York, N. Y. Tests on the Model 38 opposed-piston engines and the Model 31 stationary and marine engines are conducted on this test floor.

The design of these engines is such that the same lubricating oil may be used for testing all of them.

Test procedure requires a wear-in run of 16 to 24 hr at light loads and lower than rated speeds. This is followed by a 22-hr full-load, full-speed run, a 2-hr 120 per cent load run, and a 5-hr variable-load test. Wearing parts are then inspected and a final test run of 2 to 8 hr is made. This is the so-called "commercial" test procedure. It is modified somewhat for special applications such as for excavating equipment or for locomotive service. The lubricating oil, therefore, when it is finally drained, has seen from 50 to 60 hr of service at least half of which has been at not less than full load. This gives both engine and its lubricant a good workout.

Twenty test blocks are arranged with identical piping as shown in Fig. 2. This is arranged for extreme flexibility and permits filling and draining with the same transfer pump. There are three sections and suitable by-pass headers with cross-over valves make each one independent of the other, if necessary. A full-flow oil strainer with 0.005-in. openings is located adjacent to each engine and is cleaned at the end of each test. This strainer removes the large particles of impurities which may be present in new engines and where piping is newly connected.

At the end of each test the lubricating system is drained and the used oil is pumped into a used oil tank. This quantity varies from approximately 100 gal to 400 gal depending on the size of the engine. In this particular installation there are two used oil tanks and two clean oil tanks. Each pair consists of one 10,000-gal and one 5000-gal tank. All tanks are equipped with thermostatically controlled low-pressure steam coils which maintain a temperature of 140 F in the used oil tank and 100 F in the cleaned oil tank. New oil, as received, is put in one or the other of the cleaned oil tanks.

From the used oil storage the oil is delivered to one of two oil purifiers by means of a small transfer pump. A separate suction connection permits filling the purifiers from barrels should this be desired. The oil purifiers are of the active earth-filtering type in which the earth is agitated with the heated oil after which the charge is passed through a filter press. Each has a batch capacity of 55 gal.

The filter press consists of 10 filter units plus 3 filter-paper sections. The filter papers from the 10 filter units are cleaned off and are re-used from 10 to 15 times before renewal.

To give an idea of the over-all operation of the system, six typical oil samples were selected as follows: (1) New oil as received from supplier; (2) oil from engine base at end of test; (3) oil from used-oil storage tank as delivered to oil purifier;

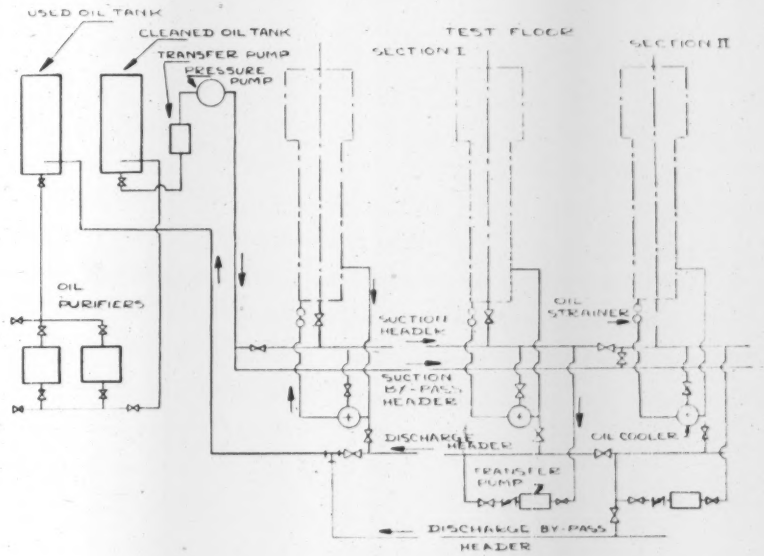

FIG. 2 ARRANGEMENT OF DIESEL-ENGINE TEST FLOOR

(4) cleaned oil as discharged from filter pack with all filter papers cleaned just before batch is run; (5) same as No. 4 except filter papers had been used for five batches; and (6) oil from cleaned oil tank as used for filling oil sumps of engines on test.

Tests indicate that the oil in the used-oil storage tank (Sample 3) is somewhat inferior to that taken from a single engine (Sample 2). This may be explained by the fact that no difficulty was experienced with the single engine from which the sample was taken, while in the used oil tank there may have been batches from some of the engines undergoing longer service tests. Some of the results are difficult to explain except to remark that the quantities are so small, making differences more apparent than real. The following comments may be made regarding the condition of the oil at end of test as compared with new oil: Flash and fire points lowered slightly, viscosity lowered, slight indication of fuel dilution, total acid number increased, sludge increased, and carbon residue increased.

However, a comparison of sample 6 with samples 2 and 3 shows the following: practically no change in flash, slightly lower fire point, viscosity practically unchanged, fuel dilution unchanged, ash and total acid number noticeably increased, and increase in sludge and carbon residue.

To show the filtering efficiency of the equipment now in use, and the effect of using the same filter papers for several batches, oil for the filter was drawn from the used oil storage. From these samples, (3, 4, and 5), filtering resulted in: practically no change in flash, slightly higher fire point, notable improvement in ash and total acid number, reduction in sludge, and restoration of carbon residue to that of new oil.

A comparison of samples 1, 5, and 6 shows the relation between the new and cleaned oil and between the cleaned oil storage (average) and that of a single batch after filter papers had been used 5 times. These analyses indicated that the cleaned oil compares with new oil as follows: flash 5 to 20 F lower, fire 5 to 10 F lower, viscosity practically unchanged, fuel dilution increased, per cent ash reduced, total acid practically equal to new oil, pentane insolubles slightly higher, and carbon residue equal or better than new oil.

In general, the results indicate that normal engine testing, as encountered on a typical Diesel-manufacturer's test floor is not a difficult assignment for a good straight mineral lubricating oil. By careful attention to purification methods the oil may be maintained in a condition practically equal to new oil.

Gas-Turbine Locomotive Operation

A REPORT on the operation of the Alco-GE 4500-hp developmental gas-turbine-electric locomotive, first reported in MECHANICAL ENGINEERING, July, 1949, pages 591–594, was given by A. H. Morey, Mem. ASME, project engineer, locomotive engineering division of the General Electric Company, during the ASME Fall Meeting held in Erie, Pa.

Some of the high lights from Mr. Morey's progress report follow:

Since its first test run on Nov. 14, 1948, this locomotive has traveled approximately 18,000 miles. Of this mileage, approximately 2000 miles was on the GE Erie test track and miscellaneous operation, about 4000 miles on eastern railroad tracks, and 12,000 miles in the west on the Union Pacific Railroad's tracks. The power plant has operated 1400 hr and it has produced 43,000,000 ton-miles of trailing load.

Tie-ups on the main track, as differentiated from time spent in sidings or terminals, totaled 3 hr 15 min out of about three months of operation. Two hours of that time is chargeable to a man failure, leaving 1 hr 15 min chargeable to the locomotive proper. Delay to other trains amounted to 20 min—the time spent by the "City of Los Angeles," waiting while flagging one block. The delays in terminals, however, have been numerous.

Availability of the new locomotive as interpreted by Mr. Morey, is the percentage of time that the locomotive is ready for service. This excludes servicing time in terminals, but does not exclude fueling time en route. The over-all figure for availability for this three-month period was about 60 per cent. Indications are that this availability can be much higher. Another definition of availability which is sometimes used is the availability of the locomotive when its services are demanded. On that basis, until three weeks before the Erie meeting, the record was practically 100 per cent.

Thus far in its test period the locomotive has been in nearly all types of freight service. It has handled drag freights, penalty freights, everything but local freights. It has been used as a helper on a couple of passenger trains. The conditions were fortunate and it made quite a name for itself in that service. It has handled one passenger train from Cheyenne to Denver.

The roadability and riding characteristics were excellent. The train-handling ability was satisfactory. Tonnage, of course, was limited by the number of motors and driving axles but the locomotive was successful in starting and handling the tonnage which the locomotive can properly haul under all of the conditions under which it has been placed. That includes standing starts with no helper on a 2.2 per cent grade.

Adhesion characteristics were outstandingly good. One of the principal reasons for this was the 20 notches on the throttle. This allowed a more careful control of tractive effort, both at starting and also under limiting adhesion conditions.

The power output of the locomotive exceeded expectations, especially under limiting conditions of high altitude and high ambient temperature.

A great deal of time in the West was taken up with various adjustments such as the power-plant-control adjustments. It was found that at relatively high elevations the characteristics which had been built into the power-plant control were not what had been expected. They were just about 180 deg out of phase. These were corrected and the net result was a performance well beyond expectations.

The fuel system was troublesome—notably leaks. Controlling fuel temperatures was also difficult. This was evidently due to unsuitable regulating valves. New valves, now installed, function properly.

The capacity of the cooling system is adequate, but vapor locks have been experienced.

One difficulty was encountered with the running gear—a resonant vertical oscillation. This was corrected by applying a small amount of damping between the sprung mass and the rather stiff leaf spring. The electric drive gave very little trouble—and none of a fundamental character.

No major troubles were experienced with the power plant itself. The starting record during road operation was very good. Misfires were almost a rarity, and little difficulty was had with leakage.

Power-plant accessories such as the governor, the fuel pumps, and the fuel nozzles, however, presented a number of problems. Difficulty with the governor was caused by one pilot valve which was inadequate for the job. An improved valve, now in use, seems satisfactory. Fuel pumps were troublesome in that they broke the flexible fuel lines because of sticky pistons. These fuel lines were redesigned, and they no longer formed a

safety valve for the distributing pump. Changes have been made, and are being made, in the pumps which it is felt will clear up this condition. A deposit of a waxy substance on the walls and pistons which, in effect, takes up the clearance in the pump and causes sticking of the individual pistons seems to be the cause. As a result of this sticking a rather violent oscillation is set up in the lines involved, with the net result that it takes a pretty good line to stand it.

Some of the combustion-chamber problems encountered were indicated by carbon deposits, warped liners, burned spots, and the like. The cause was attributed to cross leakage. However, just where the crossover occurs between the fuel and the atomizing air had not yet been found.

Special tests which were run on this locomotive include the cold-weather tests attempted last winter. The coldest weather experienced was —10 F, but it lasted only about an hour.

Hot-weather test data were taken out West up to 110 F. The performance under hot-weather conditions was good. As a result of the characteristics which have been built into the control, the falling off of power was less than anticipated.

Various elevations up to 8000 ft were tested, but most of the work was done at 6000 ft and below. Good performance was obtained at these elevations, again due primarily to the characteristics which are built into the temperature control.

At one time, following eastern experiences, tunnel operation seemed to be a serious handicap to this type of locomotive. Some changes were made before going West, and this locomotive has now operated through some 17 or 18 different tunnels of various cross sections and lengths quite satisfactorily. As yet the locomotive has not been taken through the famous Aspen tunnel. It is hoped to run upgrade through that tunnel with a trailing load. However, tests were run in the 5900-ft tunnel at Portland, Oreg. The cross section of this tunnel is not as small as the Aspen Tunnel; consequently it is not the most rigorous test that could be made. The net result of that test, however, was quite satisfactory. The light locomotive was operated through that tunnel at all speeds from 20 mph to standstill—making a stop in the middle of the tunnel. The locomotive stood there as long as the railroad people would permit, and moved out under its own power. During this test there was no measurable recirculation of hot gas into either the equipment or operator's cabs.

From here on the primary job is to improve availability. The type of fuels best suited for use in this locomotive must be found and further experience in cold-weather operation, and snow and sleet conditions, must be obtained.

Ship-Propulsion Turbines

THE increase in operating temperature of ship-propulsion steam plants to 1000 F at 600 lb pressure is as significant a step as the recent rise to 1050 F maximum operating temperature of central-station steam-power plants, according to the March, 1950, issue of the *Westinghouse Engineer*. Usual steam conditions for new ship-propulsion units are 850 F at 600 lb.

Three tankers, the first to use the new high temperature, are being built for Philadelphia Tankers, Inc. They will be completed this year by the New York Shipbuilding Corporation.

The geared-turbine propulsion equipments are being built by Westinghouse, together with the turbine-generators and switchboards for the vessels' electrical service and the many auxiliary motors and controls. The main propulsion equipment, consisting of cross-compound turbine, reduction gears, condenser, air ejectors, and lubricating-oil system, will be built as a "package" unit mounted on a single foundation built into the ship.

The electrical system, which will be 450-volt 3-phase 60-cycle, is also unique. Each tanker will have, in addition to two 750-kw turbine generators, a third generator rated 700 kw, driven from the second reduction pinion of the propulsion gear. When the vessel is running at constant speed near its maximum rating, as is usual, this geared generator can be manually switched to the auxiliary bus and will supply all auxiliary power to the ship. This scheme takes advantage of the high operating economy of the 18,000-hp propulsion turbine, as compared to that of a smaller 750-kw turbine. During steady running conditions, the attached generator will also supply power to one of the 750-kw turbine generators, operating it as a motor. This drives an auxiliary d-c generator and the exciter that supplies excitation to both the attached generator and the 750-kw turbine generator. If for any reason the ship must slow down, reducing the speed of the geared generator to below the equivalent of 53 cycles, the auxiliary turbine generator automatically picks up the load and the geared generator is disconnected from the bus.

Considerable study and experience have resulted in the owners selecting steam conditions of 600 psi and 1000 F total temperature. Indications are that the choice of steam conditions together with the unique electrical scheme will make these tankers extremely economical in operation.

Aeronautical Research

TO explore more rapidly the little-known regions of transonic and supersonic flight speeds, the co-operative industry-military-NACA research airplane project, which commenced with the USAF X-1 and Navy D-558 airplanes, has grown to include more than six airplane types. The scientific information obtained to date from this flight program has given aeronautics perhaps the greatest impetus in its history, according to the 35th Annual Report of the National Advisory Committee for Aeronautics.

Notable during the past year, the report states, has been the eagerness of aircraft designers to apply the new knowledge being obtained from the Committee's high-speed research program. Now that experimental supersonic flight has been attained, great efforts are being made by the Air Force and the Navy in fostering the design of operational transonic and supersonic aircraft. The Committee notes with satisfaction a healthy pressure upon it from the military air services and from the aircraft industry for advanced scientific data. This is the first occasion in peacetime history that organized research effort has been unable to stock-pile scientific knowledge for future use. The demand is for advanced scientific knowledge for immediate application.

In the past fiscal year, the Committee placed in operation the third of its large-scale supersonic wind tunnels. Each of these tunnels is being used to study fundamental aspects of supersonic aerodynamics and propulsion problems. For some time it has been evident that additional supersonic facilities are needed for development and evaluation purposes as well as for research. From this need has evolved what is known as the "Unitary Wind Tunnel Plan." Enabling legislation for this plan became public law on Oct. 27, 1949.

The plan aimed at the foreseeable needs of the country in the next 10 years; it recommended allocation and operating responsibilities among the Navy, Air Force, and NACA for an integrated wind-tunnel-construction program. These wind tunnels will be available for the use of all interested agencies and the aircraft industry. Provision was made for improved

research facilities at universities, not only to perform productive research but also to assure an output of qualified aerodynamicists to staff the tunnels contemplated under the Unitary Plan.

Many problems remain to be solved before tactically useful aircraft capable of sustained supersonic flight can be produced. The outstanding problems involve a better understanding of the transonic speed region through which supersonic aircraft must pass, and the development of propulsion systems giving higher thrust for longer periods of time, at increased efficiencies.

In the transonic speed region, an airplane encounters a mixture of subsonic and supersonic flow. The establishment of the physical laws governing such mixed flow will be extremely important. Since the study of transonic flow in conventional wind tunnels is not possible, the development of new experimental methods and facilities is required.

In the past few years the advent of new forms of propulsion challenged the resourcefulness of the aerodynamicist to utilize effectively the high thrusts made available. The challenge is now somewhat reversed, and it is necessary that means be found to provide improved propulsive systems for aircraft being designed for transonic and supersonic flight. Sufficient thrust is now available for short periods from rocket engines and jet engines with thrust augmentation arrangements. Progress is being made toward the development of adequate propulsion systems having the high efficiency necessary for flights of reasonable duration. What must be done is clear, but the problems are exceptionally difficult, and intensive research is required for their solution.

In addition to the primary problems of high-speed aerodynamics and propulsion, a considerable effort is required in the numerous and extensive fields of complementary research that are equally important to the achievement of useful supersonic flight. Thus, increased emphasis is being given to research on the problems of aircraft construction including such subjects as aeroelasticity, aerodynamic and impact loads, structural efficiency, and materials. Attention is also being given to research on such operational problems as icing, fire prevention, atmosphere turbulence, and emergency escape from high-speed aircraft.

The work of the Committee is in general directed toward the over-all objective of improving the performance, efficiency, and safety of both civil and military aircraft and of discovering and applying new scientific knowledge essential to continuing American leadership. The immediate objective is to solve, as quickly as facilities and personnel permit, the most pressing problems attendant on high-speed flight.

Rocket Engine

THE operating principles and sequences in the de Havilland Engine Company's Sprite, assisted-take-off rocket engine, and its associated equipment are explained in the February, 1950, issue of the *de Havilland Gazette*, by A. V. Cleaver, special products engineer of the company.

According to Mr. Cleaver's description, the Sprite rocket engine, see Fig. 3, operates on the principle that compressed air is used to feed both hydrogen peroxide and calcium (or sodium) permanganate, by displacement, into the reaction chamber. These two fluids then react spontaneously, the permanganate acting merely as a catalyst to decompose the peroxide into a jet of steam and oxygen. There is no combustion or flame in the ordinary sense; the jet (with the velocity of about 3500 fps) emerges with the appearance of a brown smoke, due to the presence of manganese-dioxide particles from the catalyst.

The Sprite has been designed to give a total impulse for take-off assistance of 55,000 lb per sec. The distribution of this impulse as between thrust and time is of relatively secondary importance (within reason, of course), but there is some advantage in using a high thrust for a short period rather than otherwise. Accordingly, the Sprite rating is for a maximum thrust of 5000 lb and a total period of operation of about 12 sec. Its weight empty is 350 lb and fully charged, 925 lb.

The unit is mounted in an aircraft on three trunnions, and can quickly and conveniently be installed in its empty condition. Using reference numbers as in Fig. 3, the air is stored in bottles (6) at 3000 psi, and then passed through a ring manifold (7) into the reducing valve (13). In this valve, the air pressure is reduced to about 500 psi by passage through a reducing orifice (16), the size of which is automatically controlled by balancing the forces of a low-rate spring (14) and the reduced air pressure acting on piston (19), so as to maintain an approximately constant output pressure.

The air at reduced pressure next passes through the air safety valve (12), provided that the mechanical cockpit control (77) is in the "on" position; if it is not, the air can get no further, so that the unit could not be accidentally fired even if the firing button (78) were operated. This cocking, or priming, operation is achieved through a servomechanism: the cam (52) compresses spring (53) and so forces the

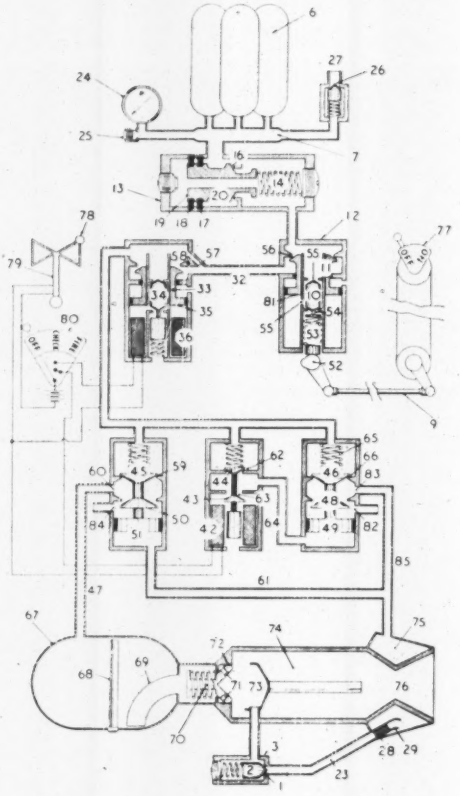

FIG. 3 SCHEMATIC DIAGRAM SHOWING OPERATION OF ROCKET

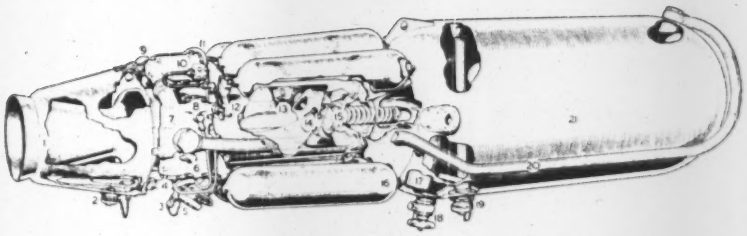

FIG. 4 CUTAWAY DRAWING OF THE SPRITE ROCKET ENGINE

[1, Catalyst tank; 2, catalyst filling point; 3, air filling point; 4, catalyst feed to injector (14); 5, air-pressure gage; 6, air-distributor valve for catalyst; 7, air-distributor valve for hydrogen peroxide; 8, starting valve; 9, air-reducing valve; 10, check-thrust valve; 11, air-feed pipe to catalyst tank (1); 12, air manifold; 13, reaction chamber; 14, catalyst injector; 15, hydrogen-peroxide injector; 16, compressed-air bottles, nine in number; 17, hydrogen-peroxide-collector pipe; 18, hydrogen-peroxide dump valve; 19, hydrogen-peroxide-filling point; 20, air-feed pipe to peroxide tank (21); 21, hydrogen-peroxide tank.]

servo shuttle valve (10) onto its upper seat and vents the chamber beneath (81) to atmosphere. The air pressure thus opens a way for itself to proceed further, due to the differential area above and below the piston (81).

The operating areas and spring forces of this valve are so chosen that it performs the dual function of a safety valve as well as an "on-off" cock. If for any reason the air pressure should attain a value unsafe for the tanks to withstand, then piston (81) moves to the upper or closed position (as drawn), regardless of whether the cockpit control (77) is set on or off.

The "check-thrust" valve (33), next in the circuit is similar in design to (12), except that it is electrically instead of mechanically operated. Its purpose is to permit a brief burst of thrust, at a reduced value, to check satisfactory operation before take-off. It does this by inserting a further restriction in the air-flow path when its solenoid is energized, so reducing the pressure to a lower value and hence feeding the fluids at a reduced rate into the chamber, giving the reduced checking thrust. This is done for reasons of economy; during a check-thrust firing, everything operates as for one at full thrust—and this valve (33) additionally. A cockpit selector switch (80) determines whether the action of depressing the firing button (78) will energize both solenoids (36) and (42), for check thrust, or merely (42) for full thrust.

Following the check-thrust valve, the air pressure reaches the firing or starting valve (44) and the air-distributor valves (45) and (46). When the starting valve solenoid (42) is energized, air can flow into the chamber beneath piston (49). Due to the differential area design of this servo valve (46), it is moved over to permit air to flow into the catalyst tank (75) surrounding the nozzle.

Once the catalyst tank is pressurized some air is bled off along pipe (61) to operate a second air-distributor valve (45). This is of similar design to (46) but larger, and admits air to pressurize the hydrogen-peroxide tank (67). The arrangement of valves (45) and (46) in series, in this fashion, insures that catalyst will "lead" peroxide into the chamber (74) and be ready, waiting to decompose it immediately upon arrival—another essential safety feature.

When the tanks (75) and (67) are pressurized, spring-loaded injectors (2) and (70) open to admit the propellant fluids automatically into the chamber (74), where they react spontaneously on meeting. The peroxide injector (70) is of the two-stage design, so that initially only a small flow is admitted through the small ports (71), to insure a smooth start. The normal maximum tank pressure is about 450 psi, and the chamber pressure 300 psi.

Underwater Aircraft Testing

A NEW technique for checking the fuselage of an airplane for pressurized flight at high altitudes has been incorporated into the production line at Airspeed's Christchurch factory in Portsmouth, England. The fuselage of the "Ambassador" airliner is being lowered into a deep-sea dock at Portsmouth as part of the routine structure testing.

In the past, air was forced into a sealed fuselage under pressure and when the failure finally occurred the fuselage blew out like a burst balloon. The underwater tests make it possible to discover exactly where a failure will take place, should one occur during testing. Two separate fuselages were used, one to test the control cabin, the windows, and the detail structure, and the other to check the center section area and complete fuselage aft of the control-cabin bulkhead. In the tests the fuselage showed that it could stand up to a pressure well above the maximum requirements—reaching 9.9 psi in the first case, and 9.8 psi in the second before failure. These figures compare significantly with the normal pressure differential which will actually be used in the Ambassador, 4.16 psi.

Helicopters

Piston-Engined Helicopters

IN a paper entitled, "Helicopters: Their History, Development, Construction, Operation, and Future," which appeared in the fourth quarterly issue, 1949, of the New York City *Municipal Engineers' Journal*, I. B. Laskowitz, Mem. ASME, properly called the helicopter, "The Universal Flying Machine" because of its ability to fly forward or backward, to one side or the other, up or down, and to hover or remain suspended in space. In addition to this universal movement, helicopters currently flying are provided with the important safety feature so that, in the event of engine failure, they are able to descend at low velocity.

The fixed-wing aircraft or airplane requires long runways for take-off and landing with correspondingly longer runways at greater speeds, while the helicopter or direct-lift rotary-wing aircraft has the important advantage that it can take off and land without any horizontal run. Mr. Laskowitz pointed out that integrating the use of both fixed-wing and rotary-wing aircraft, especially in the New York area, will result in important gains from a commercial, civilian, and military

FIG. 5 SIKORSKY—MAIN AND AUXILIARY ROTOR HELICOPTER

FIG. 7 MCDONNELL—SIDE-BY-SIDE ROTOR HELICOPTER

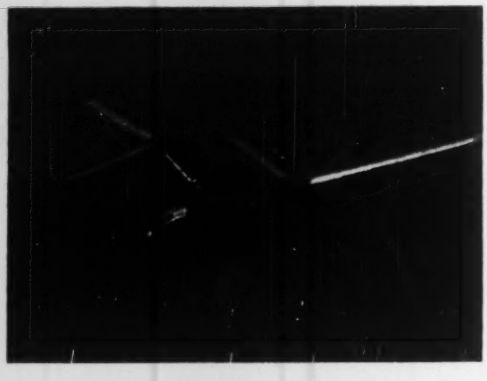

FIG. 6 BENDIX—COAXIAL ROTOR HELICOPTER

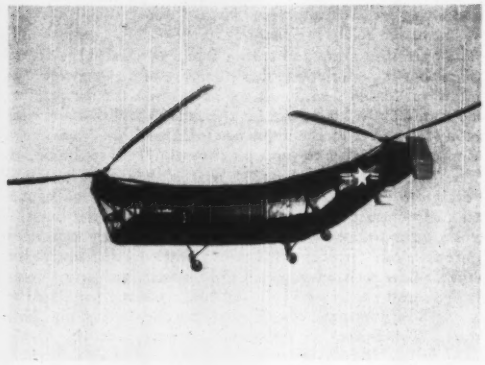

FIG. 8 PIASECKI—TANDEM ROTOR HELICOPTER

standpoint, and at the same time help relieve the ever-mounting congestion of traffic.

The City of New York acquired its first helicopter for the Police Department in July, 1948, as a supplement to its fixed-wing aircraft, to increase the effectiveness of rescue and patrol work, and the purchase of additional machines is expected in the near future.

The first commercial helicopter service in New York was officially initiated by the Metropolitan Aviation Corporation in May, 1949, with its base, known as Heliport No. 1, located on Pier No. 41, Manhattan. The pier was leased from the city and provides a platform about 60 ft wide × 160 ft long. The roofs of city-owned buildings and other properties should be designed for future helicopter operations so as to bring air transportation to the heart of the city's most densely populated centers, Mr. Laskowitz said.

A successful helicopter mail service has been operating in Los Angeles, Calif., for more than two years, and in the Chicago area for more than one-half year, the paper said.

The Civil Aeronautics Board (CAB) has held public hearings recently in New York on applications made by several airline companies for a scheduled helicopter service to fly mail, property, and passengers in the New York City area, including New Jersey and Connecticut. The need for such a service, Mr. Laskowitz indicated, cannot be too strongly emphasized.

Figs. 5 to 8 show the four types of vertical-axis helicopters that are currently flying. These embrace the following types: (*a*) a main rotor and auxiliary tail rotor; (*b*) two co-axial counterrotating rotors; (*c*) two side-by-side counterrotating rotors; and (*d*) two tandem counterrotating rotors.

Pulsejet Helicopter

Military value of the pulsejet helicopter as a ground and air forces auxiliary became increasingly evident with the start, recently, of advanced flight tests of the American Helicopter Company's "Top Sergeant," at Manhattan Beach, Calif.

Weight, pay load, structural simplicity, and cost features are said to combine favorably to focus active interest on jet power in a wide range of rotary-wing designs.

The trend of data accumulated during a year of preliminary development leading up to the present flight program indicates that the pay load of a pulsejet helicopter for a flight of one hour's duration should be double that of a piston-engined helicopter of the same gross weight; production cost should be one fourth that of today's lowest-priced commercial helicopter; pulsejet maintenance and overhaul costs should be less than 25 per cent of similar costs on a conventional helicopter; use of lowest grades of kerosene or jet fuel by the

FIG. 9 PULSEJET HELICOPTER SHOWN AT START OF FLIGHT TESTS FOR U. S. AIR FORCE

pulsejet machine should lower fire risks and operating costs materially.

It was reported that it may not be too long before production can be considered. Many engine problems have been eliminated. Early engine designs which failed under whirl loads of up to 200 g have been corrected and now show no structural weakness. Pulsejet-engine valve blocks, the only moving engine component, which once had a relatively short life expectancy, now are performing for hours, and improved designs now under test should have a life of 30 hr or more. Replacement of a worn valve block can be accomplished in the field in five minutes, and is the only major overhaul required for a pulsejet.

A new engine configuration evolved just recently will reduce substantially the drag of pulsejets mounted at rotor tips and reduce autorotation problems, it was revealed. Massive pulsejet helicopters of the popularized "flying-crane" conception will carry their engines buried in the rotor structure and will present only minor engine-drag problems. Studies to date indicate that pulsejet engine size and unit thrust will not have to be increased with the advancing weight of the helicopter itself. It will merely be necessary to increase the number of engines per blade up to required thrust.

The new pulsejet helicopter's only engine-system accessories are an electrically driven fuel pump, throttle, master shutoff valves, fuel-flow gage (rotometer), and a rotary fuel-line transfer seal purchased "off the shelf" from an oil-well supply firm. Two rotor mounting bearings were shown as the only highly loaded moving parts in the helicopter's structure.

Anechoic Room

CONSTRUCTION work has been completed on one of the U. S. Navy's most unique research facilities—the anechoic or "dead" room at the Naval Ordnance Laboratory, according to the NOL *Report*. With it NOL scientists hope to solve many of the problems involving sound, particularly in the field of underwater weapons and devices.

The room itself is 50 ft long, 53 ft wide, and 35 ft high. Completely insulated with a two-inch layer of Fiberglas backed by two inches of cork in addition to the extra-thick walls which isolate it from the rest of the main laboratory building, the room is lined completely with Fiberglas wedges which protrude inward 40 in., and are 12 in. wide at the base and $4^1/_2$ in. thick. The design of the room plus the installation of the wedges and special insulation makes it better than 99 per cent echoproof. Only a few tenths of one per cent of sound emitted in the room is reflected as echo, in contrast to the nearly 100 per cent echo found in the average room with hard-surface walls.

Although the room is not completely without sound reflection, it is as nearly so as possible, still allowing space for necessary operating equipment. Lone entrance to the "dead" room is a steel catwalk arrangement which projects about 16 ft into the room some 15 ft above the wedge-lined floor. During operations the doorway is plugged by a nine-foot section of wedging, which may be wheeled easily into or out of position.

Transducers used in the sound investigations are hung from small, but extremely strong, remotely operated cranes, thus allowing sound measurements to be made from various positions within the room. During actual tests no persons will be in the room. Sound emitters and receivers used can be controlled from an adjoining laboratory. The room is expected to prove effective for sound ranging as low as 50 cps. The lowest frequency audible to the human ear is generally accepted to be approximately 20 cps. Now undergoing instrument tests, the anechoic room first was conceived by scientists of the Laboratory's Acoustics Division interested in the application of acoustic principles to underwater ordnance. Cork and Fiberglas insulation, as well as more than 30,000 Fiberglas wedges which deaden the room, were installed.

Water Behavior

ELECTRONIC computers to give a televisionlike picture of how water behaves may help make possible more efficient use of water supplies and water power, according to engineers at the Massachusetts Institute of Technology, Cambridge, Mass. Such developments are of obvious importance to water-power development, especially in times of short supply, they point out.

Under a special grant from the Research Corporation of New York, the hydraulics division of the M.I.T. civil-engineering department is studying possible applications of so-called analog computers to make hydraulic-engineering predictions faster and more accurate.

Out of the work, it is believed, may come new ways of predicting accurately and rapidly the behavior of water in all kinds of complicated systems.

Using these computers, problems such as the rise in a river below a reservoir when a flood crest enters the reservoir from above, for example, can be solved. To calculate this flooding effect requires considering the size and shape of the reservoir and its outlet, as well as the amount of water coming in.

The calculation is performed by an array of interconnected electronic computers. The results are viewed on a screen similar to that of a television receiver.

Typical water-behavior problems of practical importance occur in everyday operations of hydroelectric plants. When the gate on a 5-ft pipe to a turbine is opened, the effects throughout the water system and the plant's electric network may be widespread, important, and difficult to predict.

There is complication, too, in keeping the water pressure to a hydroelectric generating unit constant as the power load or generator speed changes. Such speed changes have subtle effects through the entire water system of the hydroelectric plant, and many of these effects are not clearly understood. Some are so complicated to calculate that power-plant engineers have never studied them; in practice, systems are empirically

made to perform adequately without a clear understanding of why they do so.

Now there is the possibility of using analog computers to obtain a scientific and relatively inexpensive solution to such problems. The result may be better performance at less cost in future hydroelectric installations.

The first problem up for detailed study is the behavior of surge tanks—devices incorporated in most hydroelectric systems to help eliminate changes in water pressure as gates and valves are opened and closed. It is planned to make a thorough analysis of such tanks—and it is hoped to evolve a definite method for determining the sizes and designs most suited to particular needs.

In a longer view, it is believed that analog computers may be a meeting ground for electrical and hydraulic engineers working on hydroelectric generating problems. Hydraulic engineers have generally made their hydroelectric-plant studies on the assumption that the electric load on the plant remains always unchanged. Likewise, electrical engineers have assumed that the hydraulic part of the problem is a basic constant. In actual practice, the two are variable and interrelated; changes in the electrical load affect the hydraulic system, and, in turn, changes in the hydraulic system affect the electric power output.

This interrelation, it is said, is not easily calculated by conventional methods. It is hoped that the use of analog computers on such problems will go beyond the simple calculations now economically feasible.

Plastics Progress

WHILE use of most metals is below wartime peaks, plastics consumption has continued upward both during the war and since 1946, 18 per cent since 1948, and more expansion planned during this year, it is revealed in the *Industrial Bulletin* of Arthur D. Little, Inc., for March, 1950. Solid plastics consumption during 1949, excluding paints, varnishes, and the like, was estimated at 1.2 billion pounds by *Modern Plastics*.

The greatest gains in the plastics field were made by polystyrene, which grew threefold between 1946 and 1949. Molded products such as picnic tumblers, refrigerator dishes, flowerpots, clothespins, and toys accounted for most of the growth. Use in refrigerator parts and masks for television lenses, as well as for wall tile, shoe soles, and floor coverings, has also grown steadily. Between 12 and 20 lb of polystyrene are used for each refrigerator unit. One market which appears almost unlimited is for premiums, such as dinnerware, small charms, and other novelties. It is estimated that at least half of this billion-dollar-a-year premium field is held by plastics; and polystyrene is the leading plastic for this use.

Perhaps the most complete conquest by plastics has been in phonograph records. Ten years ago almost all records were made of shellac, with a filler. Plastic records were first tested in 1945 to replace scarce shellac, and now less than one per cent shellac is used in the 250 million records made. Manufacturers report that plastic records are so superior that shellac can never regain its place, even if the price should drop drastically. The unbreakable, or all-vinyl records account for 15 per cent of the market, using 10 million pounds of vinyl resin. The break-resistant records, 25 per cent of the total, use two million pounds of vinyl and four million pounds of other synthetics, while the remaining 60 per cent of "shellac-type" records, so-called only to distinguish them from the other groups, use 12 million pounds of synthetic resins and only one million pounds of shellac. Both the break-resistant and shellac-type records use fillers to extend the binder resins.

In direct competition with rubber, garden hose of extruded vinyl plastic has already captured about 20 per cent of the market since it was introduced in 1946. Although slightly more expensive, it weighs only 40 per cent as much as rubber, is crackproof, nonrotting, and long-wearing.

Plastic film for window draperies was a big development of 1949, and gave real competition to the better grades of paper draperies and lower-priced cloth. Three of the largest manufacturers of paper draperies have converted to vinyl plastic film, of which 20 million yards are used monthly for textile purposes. Vinyl offers a wide variety of film thicknesses and printed designs, good draping qualities, resistance to flame and fading, and ease in cleaning. Vinylite window shades, which sell for a dollar less than the finest coated cloth shade, promise to take over much of this field in the next few years. Another similar use of vinyl film is as headrest covers on railroad seats. The plastic covers cost only two thirds as much as cloth, and can be cleaned by wiping with antiseptic solution, saving laundering costs of two cents each.

Vinyl compounds, with 360 million pounds used in 1949, have led the plastics industry in recent years, but a newcomer, polyethylene, may lead the next decade's growth. The 31 million pounds produced in 1949 doubled previous output, with the bulk of this going to electrical uses; capacity was 55 million pounds at year's end. Between 10 and 12 million pounds of polyethylene film were used in 1949, mostly for food packaging. Another 1.5 million pounds were used to make 30 million bottles; flexible refrigerator dishes were another big item, and virtually unbreakable toys are promised for next Christmas.

Plastic tableware made of melamine resin, which was introduced about three years ago, has become a real threat to traditional earthenware because of its resistance to breakage. Restaurants and institutions, the biggest users so far, have also found that it does not clatter as earthenware does in crowded lunchrooms, is only a third as heavy, and is easy to stack, since the pieces are uniform. It has good insulating properties to keep food hot or cold, and the colors, in a wide variety of pastels, are permanent. Housewives, too, seem to like these features, and the home market is opening up rapidly.

Laminated Plastics

LAMINATED plastics are made of sheets of paper or fabric impregnated with resins and bonded together by heat and pressure. Their outstanding properties are low density, high impact strength, and low thermal and electrical conductivities. Such laminates have been used extensively for more than 35 years as electrical insulation. Currently, widespread application of plastic laminates to the refrigerator and home-freezer industry has resulted from their high impact strengths at low temperatures and their low thermal conductivity. The light weight and high strength of these materials have also brought about increasing application in aircraft, especially for the fabrication of accessories and semistructural parts such as radomes, floors, propellers, wing flaps, and ducts. In these more recent uses the laminates are subjected to a wide range of temperature, and little or no information has been available on their mechanical properties at high and low temperatures.

To provide such information, the mechanical properties of eight representative laminated plastics were evaluated at the extreme temperatures of use by the National Bureau of Standards in a project sponsored by the National Advisory Committee for Aeronautics. Izod impact strengths; flexural, tensile, and compressive strengths; and elastic moduli were measured at 70, 77, and 200 F. One of the laminates studied was made of a polyester resin with glass-fabric reinforcement while the

others were of phenolic resins reinforced with asbestos fabric, paper, cotton fabric, and rayon fabric.

The tests of mechanical properties were carried out in special thermally insulated enclosures. Special jigs and fixtures were also required for the flexural and compression tests. For the impact tests, a Baldwin-Southwark pendulum-type Izod-impact machine was used. The flexural, tensile, and compressive tests employed two Baldwin-Southwark hydraulic universal testing machines located in a room in which the atmosphere was controlled at 77 F and 50 per cent relative humidity.

The tensile strengths of the high-strength-paper, rayon-fabric, and glass-fabric laminates were found to be about three times those of the cotton-fabric and asbestos-fabric phenolics. In compressive strength the glass-fabric laminate was outstanding; at 77 F its strength in the crosswise and lengthwise directions was 36,000 and 42,000 psi, respectively. The compressive strengths of the other laminates were about 21,000 psi.

It was found that the tensile and compressive strengths and moduli of elasticity of all the laminates increased at low temperatures and decreased at high temperature. Thus for all laminates except the asbestos-fabric product, the tensile and compressive strengths at 200 F were approximately half of the corresponding values at 70 F. In the case of the asbestos-fabric product, the changes in the strength values were much smaller.

The decrease in the tensile and compressive moduli of the samples with temperature was much greater from 70 F to 77 F than from 77 F to 200 F. Except for the high-strength-paper material, the over-all changes were greater for the cellulose than for the mineral-type laminates. In general, the high-strength-paper, asbestos-fabric, and glass-fabric products showed about the same variation of tensile and compressive moduli with temperature.

The Izod impact strength values for the rayon-fabric and the glass-fabric laminates were much greater than for the other materials. It was also evident that the variation in impact strength with temperature was different for plastics having different types of reinforcement. While the glass-fabric laminates decreased steadily in impact strength with increasing temperature, the cotton-fabric laminates exhibited increasing impact strength with temperature, roughly doubling their strength values between 70 and 200 F. On the other hand, the asbestos-fabric, rayon-fabric, and high-strength-paper laminates showed little variation in impact strength between 70 and 200 F.

In flexural properties the high-strength-paper and glass-fabric laminates were superior. An increase in flexural strength was noted for all the samples at low temperature; at high temperature a decrease occurred for all except the asbestos-fabric laminate, which showed no change.

The results of the Bureau's study indicate that the flexural properties of plastic laminates at high temperature are not a function of temperature only, but may be affected by further cure of the resin and loss of moisture content. It was also apparent that the effect of high humidity, in addition to an elevated temperature, may be quite different from the effect of temperature alone. Thus a severe loss in strength was noted for the high-strength-paper and one low-pressure cotton-fabric laminates at 150 F when the humidity was increased to 90 per cent.

Atomic Energy Report

THE Seventh Semiannual Report of the Atomic Energy Commission, issued January, 1950, reveals that during 1949 the nation's long-range program for the peacetime development of atomic energy made new accomplishments.

In November, 1949, the Commission authorized the building of the first experimental breeder reactor. With the start of construction of this unit, the program for producing more fissionable material and for generating power for factories and homes and ships from the energy of nuclear fission moved from pencil-and-paper planning over to the building of full-scale test machines.

Three new reactors, including the breeder, are to be built at the Reactor Testing Station established in Idaho earlier in 1949; a fourth near Schenectady, N. Y. All are either in the advanced stages of design or the first stages of building. (MECHANICAL ENGINEERING, February, 1950, pages 156 and 157). As construction of these experimental machines gets under way, reactor-development scientists and engineers are making preliminary plans for the machines to be built in the subsequent phases of the reactor-development program.

Weapons development and stock piling moved on at a growing pace during the year. Production of weapons was changed to an industrial type of operation. Design of weapons advanced. Preparation began for future proof-testing at the Eniwetok Proving Ground in the Pacific. AEC activities were co-ordinated more closely with military activities and military training.

Essential to both the power-production program and the weapons program is an adequate supply of uranium ores. This is being obtained at present. Negotiations abroad and mining and processing-plant developments at home during 1949 placed the prospects for continuing supply on a firmer basis.

The construction program of the past two years began to yield its fruit in 1949. New facilities for making feed materials and fissionable materials went into operation. The output of fissionable material set new records. New laboratories and research machines were put to work and the building of still others advanced. Basic processes for improving chemical separation of fissionable material from fission products were worked out and construction was started on facilities.

The technical and scientific staffs were recruited more nearly to the desired levels both in quantity and quality. Industrial strength was added to the program by new contractors in various fields, but especially in weapons and reactors. Basic research was put upon a broader base with many new university contracts for research.

Some of the problems of labor-management relations became more susceptible of solution. The Atomic Energy Labor Relations Panel assisted in reaching settlements of disputes in which its services were invoked.

This is not to say that the program operated in all its phases without hitch or flaw, or at the speed and with the results desired. Many technical problems await solution through basic and applied research. Only a beginning has been made at providing industry with the information service it is entitled to expect. The declassification of scientific and technical information which need no longer be held secret does not proceed at a pace rapid enough to satisfy all of the demands for such data.

Financial controls and reporting were substantially improved during the year. A continuing effort is being made to meet more adequately the requirements of flexible operations, for keeping account of where projects stand financially at all stages, and for reporting accurately and clearly the financial status of programs at frequent intervals.

Because of the vital importance of basic and applied research in nuclear science and engineering, the major portion of the Seventh Report is devoted to the research program in these fields.

For fiscal 1950 the expected dollar costs for atomic research and developments will come to about $81 million. Of this

total, $31 million is allocated to the physical sciences; $33 million toward reactor development; and $17 million to the biological and medical sciences. The report points out that the total of 5400 scientific and technical personnel employed in this research is more than 50 per cent of the total employed on the Commission program, thus emphasizing the importance placed on basic research.

In each of the previous Semiannual Reports to the Congress, the Commission has summed up the general advances made in research. The Fourth and Sixth Reports also extensively reviewed research and development programs and their results in the fields of utilization of fissionable and radioactive materials for medical, biological, health, and industrial purposes, and of protection of health during research and production activities.

This Seventh Semiannual Report presents a similar extensive review of the programs set up by the AEC, and in so far as they can be publicly stated, the results attained in the physical research programs dealing with nuclear processes, the theory and production of atomic energy, and the utilization of fissionable and radioactive materials for military purposes. This report obviously does not cover all research in nuclear fields; private research, not supported in any way by the AEC, is not reported. Within the AEC program, work which involved restricted data necessarily has been omitted.

Particle Accelerators

300-Million-Volt Betatron

A NEW 300-million-volt betatron, said to be capable of creating artificial cosmic rays 14 billion times as intense as nature's own emanations from the sun, has been placed into operation at the University of Illinois, recently.

Dr. Donald W. Kerst, University physicist and inventor of the betatron, predicted that future study of meson events generated by these powerful betatron x rays will reveal new phenomena of great significance, including a possible revelation of what holds the atom together. Cosmic-ray characteristics will be studied through microscopic examination of a series of photo exposures and direct observation of "cloud-chamber" photos.

More important to industry will be the eventual transfer of additional laws of physics from theory to practical engineering, opening new fields of design and development, according to Dr. Kerst.

The betatron utilizes the flux of a magnetic field to accelerate electrons, in this case in a doughnut-shaped vacuum tube. Its operation is like that of an alternating-current transformer. A circle of field magnets provides the orbit-restraining force. Accelerated to the speed of light, electrons are directed at a tiny platinum target from which a sharply defined x-ray beam is produced.

Dr. Kerst credited successful operation of the 300-million-volt betatron to perfection of the magnetic field through a precisely developed design. This involved a new principle of biasing which produces approximately double voltage from a given betatron size, as successfully demonstrated on an 80-million-volt model in 1948.

The main flux magnet was constructed on the university campus under supervision of Allis-Chalmers Manufacturing Company engineers. Weighing 275 tons and measuring 23 ft long, 6½ ft thick, and 13 ft high, the main magnet contains 70,000 sheets of transformer iron. Six field magnets each weigh 12 tons.

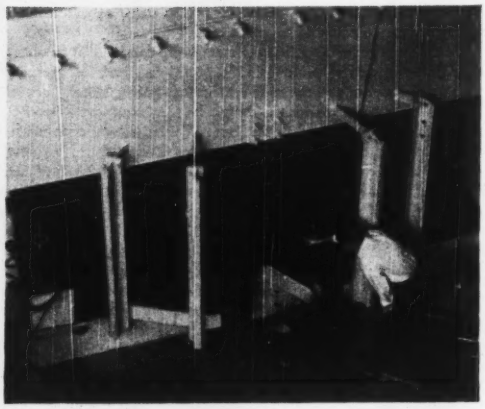

FIG. 10 POINT AT WHICH THE X-RAY BEAM LEAVES THE GIANT 300-MILLION-VOLT BETATRON OF THE UNIVERSITY OF ILLINOIS IS EXAMINED BY TWO ENGINEERS

385-Million-Volt Synchrocyclotron

What is claimed to be the world's most powerful synchrocyclotron—generating 385,000,000 electron volts—is now in operation at Columbia University's new nuclear physics research center, Nevis, Irvington-on-Hudson, N. Y.

Columbia's scientists, satisfied that the great atom-smashing machine is functioning perfectly, now look forward to a long-range study of nuclear forces which may provide new clues to the nature of matter.

At the high energies made possible by the newly completed cyclotron, mesons are produced easily, according to the Columbia physicists. Protons do not retain their identity but may turn into neutrons on collision with atomic nuclei.

Major components of the cyclotron are the 2500-ton magnet, the vacuum and radio-frequency systems, structures concerned with the proton beam, a shielding of 6-ft concrete blocks, and the control system.

Current for the magnet flows through 12 copper coils, each with a 22-ft OD. The coils are cooled by a flow of 2000 gpm of special oil which, in turn, is cooled by a maximum flow of 1000 gpm of water in heat exchangers. The water is pumped from the Hudson River.

An arc source in the middle of the cyclotron chamber generates the hydrogen gas which accelerates the protons at a velocity approaching the speed of light. When the scientists want to produce neutrons or mesons, they insert a probe in the path of the protons, and the resulting beam passes out of the chamber to the experimental area north of the instrument.

Around the great magnet is a shielding of concrete blocks measuring 30 ft in some locations, 20 ft in others. The two "doors" to the chamber are 15-ton blocks, mounted on tracks, which are propelled by attached motors.

In the experimental area of the main building are the cloud chamber and related equipment, all enclosed in a temperature-controlled housing. A bank of submarine batteries supplies the power for a special magnet used to determine the momentum of particles within the cloud chamber. Here, also, are ionization chambers, proportional counters, scintillation counters, amplifiers, and sensitive electronic devices used to detect high-energy particles and nuclear processes.

In the laboratory building to the north are coincidence circuits, scalers, remote-control circuits, and radioactivity-measurement devices. A photographic darkroom is equipped to handle cloud-chamber photography.

Marform Process

A MAJOR development in the art of sheet-metal forming which promises deeper draws, reduction in tooling costs, and greater production speeds, was demonstrated recently to press representatives and government agencies at The Glenn L. Martin Company, Baltimore, Md. The development, called the "Marform process," consists of an attachment which enables existing hydraulic presses to produce a variety of sheet-metal forms and deep-drawn parts with such precision that subsequent hand finishing is unnecessary. While still in the final stages of development, the process opens up new vistas of economies in the aircraft industry where most of the 40,000 parts, that go to make up a modern aircraft, call for precision sheet-forming. Virtually unexplored is the application of the process to other industries in which sheet-forming plays a part and where frequent changes in design impose a heavy charge for die tooling.

The process is embodied in a special attachment to be installed on the bottom platen of any hydraulic press. Its virtue lies in its ability to combine the best features of the two forming processes in common use today; the steel-die process, and the Guerin rubber-forming process which utilizes the plasticity of a rubber pad as the female half of the forming tool. By manipulating components which are essentially those of the Guerin process, the new attachment is capable of producing deep-drawn parts of aluminum alloy and steel which formerly could be produced only by the steel-die process. Thus the new process does away with the high tooling costs associated with the steel-die process and removes the production limitations which are characteristic of the Guerin process which was designed for the extreme in economy on very simple parts. In addition the new process produces precision shapes at production speeds which cannot be approached by the conventional techniques.

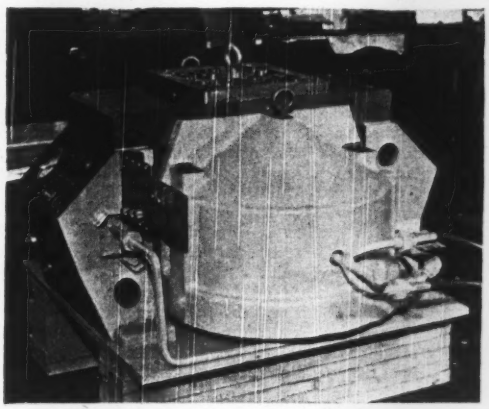

FIG. 11 CLOSE-UP VIEW OF MARFORM PROCESS ATTACHMENT WHICH ENABLES EXISTING HYDRAULIC PRESSES TO PRODUCE A VARIETY OF PRECISION SHEET-METAL FORMS AND DEEP-DRAWN PARTS

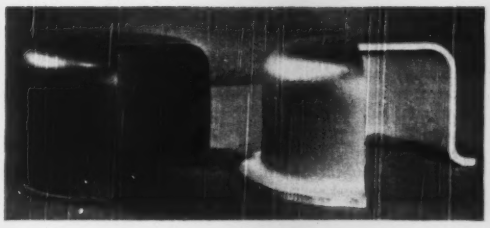

FIG. 12 BOTH OF PARTS PICTURED—ONE OF 0.030-IN. 1010 STEEL; THE OTHER OF 0.25-IN. 6150 ALUMINUM—WERE FORMED BY THE MARFORM PROCESS ON THE SAME TOOL WITH A SINGLE STROKE

In explaining how the Marform attachment operates, R. Burt Schulze, general supervisor of The Glenn L. Martin Company's Manufacturing and Development Division, compared the new process to the two conventional methods of forming from which it springs. In the steel-die process a blank is placed between an expensive punch or male member and the die, female member of the tool, and pressure is applied to force the blank into the die. If the part to be drawn is deep, the diameter of the blank must be much larger than the finished diameter of the part. In deep-drawing operations, therefore, the outer periphery of the blank must be shrunk radically without wrinkling as the pressure is applied, so that the unformed part of the blank can enter the space between the punch and the die. To prevent such wrinkling, the steel-die process utilizes spring or pneumatically loaded pressure pads to hold the unformed blank sufficiently firm to prevent wrinkling, yet without restraining it from entering the die. Ideally the pressure on the pad should vary with the forming stroke, and the pressure curve should be adjusted for every shape and material formed. The inability to control this pressure during the forming stroke or to adjust it readily for different shapes and materials, imposes a severe limitation on the steel-die process.

In the Guerin process rubber confined in a retainer is used for the normal metal female portion of the forming tool, but since there is no good substitute for the pressure pads to prevent wrinkles, the process cannot be used for deep drawing. Its use in the aircraft industry has been confined to forming operations involving straight bends, stretching of metal, and slight shrinking of metal on convex flanges. However, in shapes incorporating any appreciable convex flange, which necessitates shrinking of the metal of the flange, the lack of a pressure-pad function causes the material to pile up in a series of wrinkles.

In the Marform process the rubber retainer of the Guerin process is used in combination with the Marform attachment, into which the hydraulic cushion is designed to provide a pressure-pad effect and to give infinite control of pressure applied to the blank throughout the forming stroke of the press.

Thus the new process combines the forming ability of the steel die with the economic tooling of the Guerin process. Other advantages are claimed for it. While it does not give the embossing definition of a steel die, the attachment outperforms the steel die in many important aspects. With aluminum alloys a steel die is capable of a 40 to 50 per cent reduction of area. The new device is capable of 57 to 70 per cent. While the steel die will normally permit a cup depth equal to the radius, depth-to-radius ratios of 1.5 can be easily obtained with the process, and ratios as high as 2.4 have been achieved in one operation.

Other advantages claimed for the process are as follows:

(1) Its ability to produce rapidly sheet-metal forms to tolerances of plus or minus 0.002 in.; and (2) its ability to use thin materials. Sheets of 0.01-in. thickness have been formed successfully, and a 0.012-in. cup was deep-drawn to a depth-to-diameter ratio of 0.9. Gages as thick as 0.675-in. aluminum alloy and 0.102-in. 1010 steel have been worked.

Application of the process to sheets previously coated with such finishes as vinyl, and aircraft and crackle paints, has demonstrated that the process can produce shapes without marring such surfaces. Material polished in the flat state have been drawn without damaging polished surfaces.

At The Glenn L. Martin Company's Baltimore plant the process has been used on 800 and 3500-ton hydraulic presses whose speeds of production were limited to 120 cycles per hr. Company engineers are confident that the attachment can be used at higher speeds and on mechanical presses.

Engineers Needed

UNLESS the percentage of high-school graduates entering engineering colleges is increased, there is a strong probability that instead of a large surplus of engineering graduates, which has been prophesied rather widely, there will soon be fewer engineering graduates available than are needed. This is the conclusion drawn by a subcommittee of the Manpower Committee of the American Society for Engineering Education from a study of trends in secondary-school and engineering-college enrollments, and of the statistics on 1949 engineering enrollments and graduations recently assembled jointly by the ASEE and the U. S. Office of Education.

Freshmen in the fall of 1946 numbered about 93,000 in all U. S. engineering colleges listed by the U. S. Office of Education, and constituted 8.6 per cent of high-school graduations of the preceding June, compared to a prewar average of about 3.2 per cent. Other classes were also large, and an oversupply of engineers was predicted.

Freshmen engineering enrollments have declined steadily since 1946, until in 1949 they constituted only 3.0 per cent of the June high-school graduates, and made up a class of 42,000, no larger than it would have been had prewar trends continued undisturbed through the war years.

Of the 93,000 freshmen engineering students of 1946, 55,000 are now seniors. If the "survival ratio" of last year holds, there will be about 51,000 engineering graduates in 1950. Assuming a gradual return over the next three years to prewar survival ratios, indicates about 35,000 engineering graduates in 1951, about 25,000 in 1952, and about 19,000 in 1953. Prewar ratios applied to U. S. Office of Education estimates of future high-school seniors indicate a steady decline in engineering graduates beyond 1953 to a low point of about 15,000 in 1957, followed by a slow rise to about 21,000 in 1965.

A Bureau of Labor Statistics report estimates an average need for engineering graduates of between 17,000 and 18,000 per year during the early 1950's, rising to an average demand of about 22,000 per year by 1960. This is based on the engineers needed for *actual engineering jobs*, including anticipated expansion and the replacement of engineers who die, retire, or leave the profession. However, a recent survey by the Engineers Joint Council of the actual placement results in engineering colleges indicates that about 35,000 graduates of last year's class have actually been placed in jobs which utilize their engineering training.

Manpower Committee reports emphasize that not only the total number of engineers but also the ratio of engineers to total employment are steadily rising. Contributing factors are the increasing need for engineering and research in industry and Government, the development of new processes, and the tendency to recruit engineers for nonengineering jobs but for which an engineering background is desirable.

By 1953 engineering graduates are expected to be fewer in number than the Bureau of Labor Statistics estimates will be needed for *actual engineering jobs*. From 1954 to 1965 a serious shortage of engineers will develop unless the ratio of freshmen engineers to high-school graduates increases.

Gas-Turbine Auto

THE story behind the world's first gas-turbine automobile, recently introduced by the Rover Car Company of Birmingham, England, goes back five years; and another four or five years must elapse before a turbine-engined car becomes a practical proposition for sale to the public, writes Lawrence Pomeroy, technical editor of *The Motor* (London).

In considering what the turbine-engine car has to offer the ordinary motorist, states Mr. Pomeroy, it is first essential to remove any misconception that the jet principle is involved. The fact that these new types of prime mover (initiated by Air Commodore Frank Whittle in England as far back as 1936 and somewhat later in Italy and Germany) are based upon a pressure gas-generator unit which performs in the following fashion: Air is drawn into a bladed compressor rotating at between 20,000 and 40,000 rpm, according to the type and size employed. This air is then fed at about 45 psi to combustion chambers into which a continuous stream of fuel (usually kerosene) is injected and burned. The bulk of the energy contained in the burned gases is then passed through a driving turbine connected to the air compressor but there is a balance of energy which can be used for useful purposes.

The most simple method of employing it is in a jet, but for reasonable efficiency this application is confined to aircraft traveling more than 400 mph, and preferably at around 40,000 ft altitude. For lower-speed, lower-altitude aircraft, good use can be made of the remaining energy by using it to turn a third-power turbine wheel connected to a conventional propeller, and from this it will be seen that a logical application of the principle is to couple a smaller version of such a layout to the propeller shaft of a motorcar.

This is what the Rover Company has done. There is first, the air compressor, combustion chambers, and compressor driving turbine, which together form a gas-generating plant. By controlling the flow of kerosene into the combustion chambers the speed at which the rotating parts run can be varied from about 7000 rpm for idling to approximately 40,000 rpm on full speed. As these speeds change so does the volume and pressure of air delivered to the combustion chambers, and this controls the surplus energy which can be fed to the power turbine, which is joined to the rear wheels through the medium reduction gears of about 25:1.

No clutch or gearbox is required since the gas-generator unit can be run on full speed (and hence at full pressure) when the car is stationary, and, for example, if the hand brake is kept on at the time when full throttle is applied the maximum effort for acceleration is available immediately the hand brake is released, and there is a continuous gain in speed up to the highest of which the car is capable.

In view of the very high rotational speeds it is obvious that perfect balance is essential and from this it follows that a gas-turbine engine is inherently extremely smooth-running and vibrationless. This, coupled with the simplicity of driving, according to Mr. Pomeroy, gives it a great advantage over the piston engine, and it has the further merit of being extremely light and compact so that great power can be developed without

a large space being needed under the hood. The Rover engine will actually develop nearly 200 hp, and fits into a relatively small space. Size for size, and weight for weight, one may reasonably expect the turbine car to have a 25 per cent higher maximum speed than a piston-engined vehicle, together with far better acceleration and hill-climbing powers.

Manufacturing costs have yet to be assessed, but there is no reason to believe that they would be excessive, Mr. Pomeroy revealed. The principal price to be paid will be the high fuel consumption. Since the gases have to pass through three pumps between their entry into the engine and their final discharge through the exhaust system, and even if each pump can be made with an efficiency loss of only 15 per cent, there will still be an over-all loss of efficiency of nearly 40 per cent from this cause alone.

Also, the compression ratio in the turbine engine is about half that of the advanced piston engine and this results in a further loss of efficiency which could only be offset by a larger consumption of fuel. The Rover engine, publicly demonstrated was not complete, in that there was no silencer on the exhaust system, nor was there a heat exchanger to extract the last fraction of useful energy from the gases and to return it to the generating system. When these additions have been made the car should be extremely quiet-running and a fuel consumption of around 15 mpg should be obtainable.

A wide variety of fuels can be employed, including kerosene and heavy fuel oil.

The tests showed that the engine would run steadily in less than 15 sec from pressing the starter button with the compressor turbine running at about 7000 rpm. On opening the throttle the car would move away when the compressor shaft reached 13,000 rpm and reached 60 mph in under 15 sec. In its present early experimental form full use is not being made of the available power but even so 90 mph is readily obtained.

The engine is installed in a three-seater open car, mounted ahead of the rear axle but behind the seat, the position being dictated by accessibility and ease of making a slight modification during the development period. The fact that the compressed air does double duty for combustion and cooling does, however, make the gas turbine an attractive type for designers who wish to build rear-engined vehicles. Other practical features which will be valued by the motorist should be long life between overhauls and negligible oil consumption.

Synthetic-Fuel Costs

REFINED synthetic-fuel products can now be produced from oil shale and coal at actual costs averaging 7.3 and 10.8 cents per gal, respectively, according to an announcement by Secretary of the Interior, Oscar L. Chapman. If a profit of 6 per cent on the average unamortized capital investment is added, plus income taxes, the wholesale price for products at the plant would average 9 cents per gal for those from oil shale and 14.5 cents for those from coal.

Further reductions are certain as our knowledge is extended, the Secretary said in his 1949 annual report to Congress on achievements of the Bureau of Mines in synthetic liquid-fuels research and development. With emphasis now centered on operation rather than design and construction of laboratories and demonstration plants, the synthetic-fuels program has entered its most valuable period and is making rapid strides. Many technical problems still must be solved, but additional process improvements that will assure adequate supplies of liquid fuels from domestic resources at reasonable costs are expected.

When established, Secretary Chapman stated, the synthetic liquid-fuels industry will provide new employment and a needed stabilizing influence on the position of coal in the nation's fuel economy.

With more than half of all the fuel energy used in the United States now being provided by petroleum and natural gas, it is obvious, he said, that the security of our liquid-fuel position would be greatly enhanced if the supply could be based in an increasing degree on oil shale and coal, which comprise more than 95 per cent of our total fuel reserves.

Trends of the last three decades have been in the opposite direction, however, he said, citing significant per capita fuel-consumption figures. Since 1920, coal consumption has dropped from about 6 tons per person to $4^1/_2$ tons, while oil usage has increased from $4^1/_2$ to $14^1/_3$ bbl, and natural gas from 7500 to about 35,000 cu ft.

At the request of the Secretary of the Interior, the Army's Corps of Engineers is making a comprehensive survey of 39 states and Alaska to determine not only the availability of raw materials for commercial synthetic-fuels plants but of water, power, transportation, labor, housing, and markets as well. Sample surveys completed in parts of Colorado, Kentucky, Montana, and Texas indicate that there will be no scarcity of suitable sites, for these areas alone could support plants producing up to 7 million bbl of gasoline and oil daily—about 20 per cent more than present consumption. (See MECHANICAL ENGINEERING, December, 1949, page 1045.) As the general survey progresses, reports will be published by the Bureau on each of the states having reserves of coal, oil shale, natural gas, and tar sands.

The capital investment now required for a plant producing 10,000 bpd of crude shale oil, or 8840 bpd of refined products, is estimated in the report as $41,381,000, including facilities for mining, retorting, and refining. This is an average of $4138 for each daily barrel of crude-oil capacity or $4681 per daily barrel of finished product. This plant would produce jet and Diesel fuel primarily, plus a small amount of fuel oil. The removal of sulphur and nitrogen is no longer a serious problem, the report said, and motor gasoline may be produced readily by modification of the refining process.

Production costs for shale-oil products even now are within or very near the competitive range of those from petroleum. Another problem remains, however—a market for the products. The oil-shale area of western Colorado is sparsely populated and could not absorb the entire output of a 10,000-bpd plant. Construction of a 50,000-bpd pipe line could provide transportation to large consuming centers at a total cost of less than 1 cent per gal, but would require the output of five 10,000-bpd plants for capacity operations. This means that a large capital outlay of approximately $240 million would be necessary for plants and pipe line at the start of commercial development.

The estimated capital investment for a modernized coal-hydrogenation plant producing 30,000 bpd is $246,800,000 or approximately $8227 for each daily barrel of product capacity. High-octane gasoline would be the principal product. By-products would include liquefied petroleum gases and phenols, for which there is a growing demand. As coal-hydrogenation plants are highly flexible, the product distribution readily could be changed to include aviation gasoline which would improve the profit possibilities. Aviation fuel (100/130 grade), now quoted in the coal regions at 16 to 18 cents per gal, could be sold at the plant for 16.6 cents per gal wholesale as compared to the 14.5 cents per gal that would be required for automotive gasoline from coal.

Operation of a limited number of coal-hydrogenation plants to produce chemicals as a major part of the products may be very attractive, the report notes.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Petroleum Mechanical Engineering

Diesel-Electric Drilling Rigs, by E. H. Lamberger, Westinghouse Electric Corporation, East Pittsburgh, Pa. 1949 ASME Petroleum Mechanical Engineering Conference paper No. **49—Pet-10** (mimeographed).

The Diesel-electric direct-current variable-voltage transmission was first used on an oil-well drilling rig in 1929. This paper describes briefly the progress from that time in Diesel-electric drilling equipment, the various types which have been built, and outlines modern types of equipment.

Since 1929 total generator capacities have increased from 280 kw to 1500 kw. A variety of types of equipment have been built including equipment for land and marine operations, full-electric, semielectric, or rotary-table drive equipment, equipment with series or parallel generators, and single or multigenerator equipment. Simplicity of equipment, to assure a high degree of continuity of operation consistent with operating requirements, has been a criterion in the electrical developments.

The capacity and operating features of the electric transmission have kept pace with the requirements for deeper and faster drilling. The electric transmission frequently has been applied to rigs planned with unusual features of construction, or for unusual types of operation. They have been used successfully in both wildcat and proved-field drilling.

More powerful equipment for drilling faster and deeper, in proved or wildcat locations of any type, will require an ever-increasing degree of flexibility and ease of power control. More convenient finger-tip control by the driller will be required, as well as more indications and records of operations as offered by metering of drive performances. The electrical transmission can meet the needs of all these requirements.

Mud-Pump Selection, by H. L. Willke, The National Supply Company, Toledo, Ohio. 1949 ASME Petroleum Mechanical Engineering Conference paper No. **49—Pet-14** (mimeographed).

This paper presents a method of determining mud-flow pressures and the resulting mud-pump loads. Mud-pump requirements are analyzed for deep drilling. The advantages of multiple-pump operations are stressed. Various types of drives are discussed and the features evaluated.

It is pointed out that flow-of-slush data have been developed to the point where pump horsepower requirements can be anticipated and proper pump sizes selected to obtain maximum performance. Because the advantages of higher annulus velocity and greater jetting at the bit nozzles are being recognized, higher hydraulic circulating power is required. Higher-powered lighter-weight pumps, and parallel and series operations are available for these conditions. Pump designs must be well-balanced and ratings and applications made with some conservatism to give satisfactory life under the widely varying load conditions encountered in drilling.

Stage Separation, by Garman O. Kimmell. Kimray, Inc., Britton, Okla. 1949 ASME Petroleum Mechanical Engineering Conference paper No. **49—Pet-15** (mimeographed).

Stage separation is defined as a method producing crude oil or "distillate" by subjecting the well stream to a series of flash vaporizations in successive pressure reductions.

Two types of gas liberation define the limits of the separation of solution gas from a liquid. The one yielding the most vapor and the least liquid is called "Flash Vaporization." The one yielding the least vapor and most liquid is called "Differential Vaporization." Flash vaporization is defined as a liquid system from which the gas is not removed from contact with the liquid as reduction in pressure allows the vapor to come out of solution. In differential vaporization, gas is removed from contact with the liquid as reduction in pressure allows the vapor to come out of solution.

Differential vaporization, of necessity, is a "batch process" and not easily executed in the oil field. Differential separators have been designed and operated, however, two units, each capable

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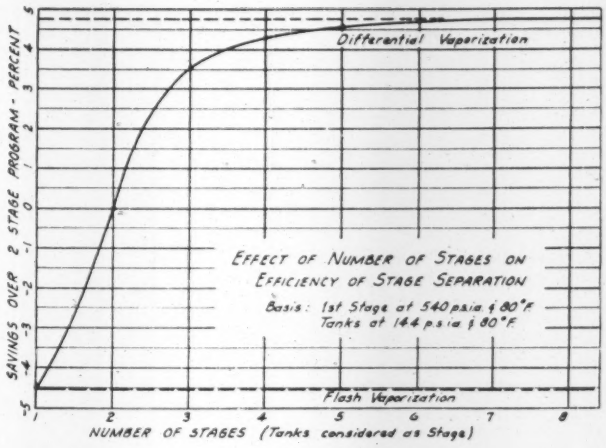

Differential Vaporization
Effect of Number of Stages on
Efficiency of Stage Separation
Basis: 1st Stage at 540 psia & 80°F
Tanks at 14.4 psia & 80°F
Flash Vaporization
SAVINGS OVER 2 STAGE PROGRAM - PERCENT
NUMBER OF STAGES (Tanks considered as Stage)

EFFECT OF NUMBER OF STAGES ON EFFICIENCY OF STAGE SEPARATION

of the initial pressure, are required to provide an installation capable of receiving flow continuously. This, together with the prerequisite controls for the differential unit, makes it more expensive than a stage program of several separators and tanks.

In this paper stage separation is examined in the light of processes which constitute its absolute limits of performance. Particular attention is given to volumes of gas from the stages and to the natural-gasoline contents of those vapors. Economics surrounding the stage-separation process, interstage pressures and their effects on efficiency, and the choice of first-stage pressures for the production of high-pressure flowing wells are discussed.

The paper points out that stage separation is a production-process tool and provides a method of conservation in all applications where all but first-stage vapors are wasted to the atmosphere. The universal application of stage separation to all production economically justifying it would convert wasted hydrocarbons into jobs and capital assets.

Corrosion-Resistant Liners in Refinery Vessels and Equipment, by G. C. Carpenter, Esso Standard Oil Company, Louisiana Division, Baton Rouge, La. 1949 ASME Petroleum Mechanical Engineering Conference paper No. 49—Pet-17 (mimeographed).

In general, corrosion-resistant liners are employed for reasons of economy. The natural constituents of the crudes being processed may corrode equipment or may give rise to corrosive agents during the distillation process. In addition, many processes take on a chemical aspect in that certain corrosive chemicals, such as sulphuric acid, hydrochloric acid, sodium hydroxide, and others, are utilized in the formation of desired end products.

The paper points out the following:

Strip-welded liners present considerable economy over plug-welded liners due to ease of installation and quality of over-all welding, as well as being easier to maintain and repair once the liner is in service.

Ferrous-strip liners may be butt-welded, but nonferrous strips should overlap on one or both edges so that exposed welds will remain uncontaminated by carbon-steel pickup from the base metal.

Relatively wide strips, perhaps 6 to 8 in., may be used in low-temperature service. As temperatures increase, progressively narrow strips should be considered with probably a 2-in. width for 18–8 chrome nickel steel above 800 F.

To combat sulphide corrosion at high temperatures, 18–8 chrome nickel steel has been used; at low and medium temperatures, monel liners have been satisfactory in this service, as well as for services where chloride corrosion is known to exist.

Inconel is being used to combat both general corrosion and stress corrosion cracking at caustic injection points in crude processing units.

Test exposure of International Nickel Company type corrosion spools in the process streams involved is felt to be the most satisfactory method of selecting liner material for refinery vessels and equipment.

Glass-lined equipment presents an unsatisfactory maintenance problem unless special handling techniques are employed.

Hastelloy B has given good service in acid-pump casings as a welded-in, or deposited-metal liner. Hastelloy B sheet offers good possibilities as strip-liner material in hydrochloric-acid and sulphuric-acid service.

Plastic coatings offer much promise as corrosion-resistant liners in atmospheric-temperature service.

Secondary Recovery Equipment Selection, by J. H. Field, Mem. ASME, Sohio Petroleum Company, Oklahoma City, Okla., and E. N. Kemler, Southwest Research Institute, Houston, Tex. 1949 ASME Petroleum Mechanical Engineering Conference paper No. 49—Pet-18 (mimeographed).

The selection of equipment for secondary-recovery operations involves several factors not normally encountered in primary-recovery operations. The economic factors in secondary-recovery operations are usually quite critical so that the last item in the development is cut to the irreducible minimum. The selection of pumping equipment is therefore generally not given proper consideration. Since the production costs are so critically tied up with maintenance expense and determine the life of the flood, the selection of pumping equipment and proper operating specifications is much more important than generally considered.

Pumping requirements, problems of selecting equipment, the pumping unit, subsurface pumps, etc., are discussed.

In selecting equipment for water-flooding operations, the paper states, consideration must be given especially to the length of stroke and strokes per minute. Fast pumping speeds are causing premature failure of pumps. A pumping unit with longer strokes than now available is desirable for same unit-structure load rating.

Consideration should be given to the use of $2^1/_2$-in. rather than 2-in. tubing in order to make use of rod-insert pumps in the larger sizes.

Corrosion of subsurface pumps is an important factor in water-flood operations.

Selection of the capacity of surface equipment should be simpler than for primary recovery operation.

Development of Unitized Well-Control Manifolds, by Marvin R. Jones, Oil Center Tool Company, Houston, Texas. 1949 ASME Petroleum Mechanical Engineering Conference paper No. 49—Pet-19 (mimeographed).

This paper deals with equipment used at an oil-well site to control the production from the well.

There are two major divisions in the production equipment at the top of the well. The lower group, consisting of the casing heads and the tubing head, comprises the "well head assembly." The upper group, consisting of the tubing-head adapter, the master valve, the central tee, the wing valve, the choke assembly, the bottom hole test adapter, and the gage cock and pressure-gage assembly comprises the "Christmas Tree."

The lower section of the tree includes the tubing-head adapter and the master valve. The other section is referred to as the "Well-Control Manifold." This paper deals with this section, and outlines generally the development by various manufacturers of unitized devices adapted to perform several of the functions which the individual components of a conventional tree perform singly.

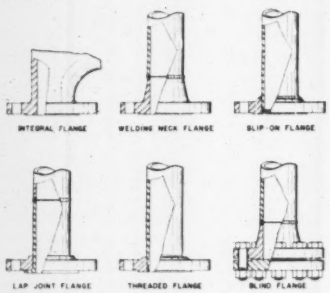
It is pointed out that there are at least three unitized well controls now being used with varied degrees of success. All such units include at least the wing valve and choke functions. Units are also available which include, in addition, the bottom-hole test adapter, downstream block, valve, the central Christmas tree fitting, and the tubing lift connection functions.

Indications are that where a unitized well control is satisfactory for use, an appreciable economy in weight, size, and price may be effected. The suitability of a unitized well control is now limited mainly by its capacity to handle high flow rates without excessive cutting but also partly by its lack of flexibility. The enlargement of the valve element passageway, together with some provision for reducing flow velocity across the sealing surfaces during opening and closing operations, would increase capacity. However, no increase in operating effort should be required.

American Standard Steel Pipe Flanges, Their Development and Proper Use, by J. D. Mattimore, Mem. ASME, Tube Turns, Inc., Louisville, Ky. 1949 ASME Petroleum Mechanical Engineering Conference paper No. 49—Pet-20 (mimeographed)

The current edition of the American Standard—"Steel Pipe Flanges and Flanged Fittings"—designated B16e—is ten years old. Now it is being completely revised although it is likely that at least a year or two will elapse before the new edition is ready for publication.

The initial requirement for the development of an American Standard covering steel pipe flanges came into being in 1921 and grew from the needs of the steam-power-plant industry of that day. Oil-refinery engineers also had an interest in the development of a steel-flange standard at that time but their need was not nearly so urgent as that of steam-power-plant designers. During the nearly 25 years the American Standard has been in existence, the use of steel pipe flanges for severe service conditions in steam-power plants has all but disappeared. On the other hand, the oil industry (and in recent years the chemical industry) has continued to have a growing need for flanges capable of withstanding high pressures and temperatures. Nevertheless, the power-plant industry has continued to have a strong interest in American Standard B16e largely because it provides dimensional data and pressure-temperature ratings for cast-steel welding end valves and fittings which are extensively used in power-plant service. It is a curious fact that the pressure-temperature ratings of such welding end valves and fittings are those assigned by the standard to ring-joint flanges of the same material.



BASIC TYPES OF AMERICAN STANDARD STEEL FLANGES

This paper, therefore, reviews the development of the American Standard for flanges and flanged fittings, points out some reasons for the existence of many of the requirements of the standard, and compares the different types of pipe flanges included in the standard from the standpoint of installed costs, method of attachment to the pipe, and over-all joint strength.

Pressure Losses in Tubing, Pipe, and Fittings, by R. J. S. Pigott, Fellow ASME, Gulf Research and Development Company, Pittsburgh, Pa. 1949 ASME Petroleum Mechanical Engineering Conference paper No. 49—Pet-22 (mimeographed; to be published in Trans. ASME).

This paper is a continuation of the second half of the problem involved in the author's 1933 paper on pipe flow, and Prof. Lewis F. Moody's 1944 paper. The pipe-flow situation is shown to be in satisfactory condition; the main attention is on bends and fittings.

It has been customary in the past to rate the losses in bends and fittings as a function of velocity head. Another old method, less used, was to rate the loss in equivalent length of pipe. In the case of bends and fittings two types of loss are superposed, i.e., skin-friction or pipe-loss type, and bend loss. The methods of test are less accurate than for pipe as they involve taking the difference between two much-larger readings. Consequently the test data are much poorer than for pipe, for several reasons, one just given; another, that the pipe fittings are not geometrically similar, and the test data are very much less than are those for pipe. It seems clear that a rational formulation, however, could be attempted if some picture of the factors involved in the losses can be established. Up to the present time bend and fitting losses have been taken from a range of factors unconnected with size, roughness, or velocity of flow. This formulation, on the basis of the tests, endeavors to show that there is a true bend loss for smooth fittings underlying the superposed losses due to roughness and Reynolds number. The final formulation involves an evaluation of the true bend loss and an evaluation of the roughness and Reynolds number effects paralleling the friction factor in pipe. The final conclusion is that the equivalent pipe length is by all means the most reliable and convenient method of tabulating losses in different kinds of fittings and bends. The final formulation is

$$\zeta = \zeta_1 + \zeta_2 = 0.106 \left(\frac{r}{d}\right)^{0.4} + 2000 f^{2.5}$$

This formulation has been checked against the test results and while it is obvious that the factors will be both plus and minus over a considerable range, the general correlation of the test data appears to be as good as our present test information will permit.

The Basis for Selecting Alloy Cast Irons for the Petroleum Industry, by Frederick G. Sefing, The International Nickel Company, Inc., New York, N. Y. 1949 ASME Petroleum Mechanical Engineering Conference paper No. 49—Pet-2 (mimeographed)

This paper describes the wide variety of properties available with alloy cast irons and the special-service types of alloy irons such as Ni-Resist and Ni-Hard. Selecting an iron which meets the peculiar demands for special service in the oil

industry requires a thorough understanding of both the service conditions and the metal which is expected to operate in that service. Great economies of procurement and operation can be exercised by the sensible utilization of various alloyed cast irons.

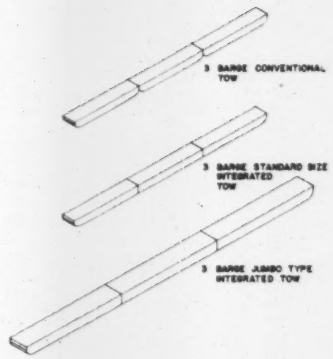
The paper discusses the properties of cast iron in service involving metal-to-metal wear, pressure tightness, abrasive wear, thermal stresses, corrosion and heat, and points out that engineers can now specify cast irons to meet the ever increasing demands of greater power from engines, higher capacity from pumps, etc., the handling of corrosives, and higher temperatures of furnaces, and other industrial equipment.

Recent Trends in Transportation of Petroleum on the Mid-Western Rivers, by J. R. Shipley, Sohio Petroleum Company, St. Louis, Mo. 1949 ASME Petroleum Mechanical Engineering Conference paper No. 49—Pet-24 (mimeographed).

The general trends in towboats have been from stern-wheel to propeller-driven vessels, from steam power to Diesel power, and toward roomier and more comfortable and homelike living quarters. The general trends in barges have been toward integrated streamline-type barges, larger individual barges, and smaller complete tows for higher-speed towing. The general trends in terminals have been toward greater tankage and higher loading and unloading rates.

The effect on crude-oil river transportation of developments in towboat and barge design, the use of radar, and reduction in port time are well illustrated by the comparative performance of the first and last tows in Sohio's fleet. The Sohio *Cleveland* and its tow, based on performance to date, will turn in approximately $4^1/_2$ times the 100 barrel-miles, or ton-miles, per year performance of the first stern-wheel steamer and its four-barge tow. The horsepower of the *Cleveland* is about three times that of the first steamer, the tow is about twice as large, and the unit requires a smaller crew.

Undoubtedly, the future will see many further improvements in vessel design, equipment to aid navigation, and general operating efficiencies. For example, for quite some time the United States Army Engineers have been studying a project which would provide a minimum channel of 12 ft on the Mississippi River system, reduce the number of dams on the Ohio and upper Mississippi Rivers, and increase standard lock length from the present 600 ft to 1200 ft. If and when such a project is completed, deeper-draft equipment can be designed and longer



BASIC DESIGNS OF VARIOUS TYPES OF TOWS

tows developed. This would result in further increasing the efficiency of river shipping.

River shipping has taken its place with railroads, truck lines, and pipe lines, and has become an important part of the country's over-all transportation system. Future economies and resultant lower costs should accelerate its rate of growth with respect to the types of cargo it is best fitted to handle (heavy cargo over comparatively long hauls). Competition by "big-inch" pipe lines, which at present can handle large volumes at lower costs, will probably tend to stabilize or perhaps reduce the volume of petroleum and its products moving by river; however, this should be more than compensated for by other liquid bulk commodities which are not adaptable to pipe-line transportation because of handling difficulties or insufficient volume to utilize big-inch pipe lines.

Characteristics of Diaphragm Motor-Control Valves, by Thomas L. Smith, Minneapolis-Honeywell Regulator Company, Houston, Texas. 1949 ASME Petroleum Mechanical Engineering Conference paper No. 49—Pet-25 (mimeographed).

Primarily and basically, it is the function of a diaphragm motor valve to receive varying air-pressure impulses from a controlling instrument, whether it be controlling temperature, pressure, or flow of the medium to be regulated. Then, to translate these varying air impulses in a true accurate linear action, a diaphragm air motor is connected through a stem to a throttling member within the valve proper, (known as a regulating disk or plug), to vary the flow of the medium passing through the valve. A diaphragm motor valve consists of two subassemblies; an air motor unit and a control-valve unit.

The characteristics and various improvements in structural design of diaphragm control valves, are discussed and described.

The Control Valve—Its Application, by J. A. Pellettere, Gulf Oil Corporation, Pittsburgh, Pa. 1949 ASME Petroleum Mechanical Engineering Conference paper No. 49—Pet-21 (mimeographed).

Control-valve applications are discussed from the standpoint of valve size, flow characteristics, rangeability, and economy. No mathematics is introduced beyond the "square-root law" relating pressure drop and flow.

Fallacies which may trap the unwary in selecting valve sizes and plug types are explained. Flow characteristics of other equipment in the system often are more important than those of the control valve.

Auxiliary devices such as governors, used instead of control valves, frequently produce great savings in energy otherwise dissipated. Automatic clutches, electrically or hydraulically operated, are predicted to become common.

The aim of this paper is to give the fundamental considerations in sizing control valves, and in selecting plug design without resorting to complicated mathematics. In so far as possible, examples of applications are taken from actual experience of the author and others rather than hypothetical cases.

In summary, the paper states the following:

If the control valve is the only load in the circuit, sizing is no problem. The valve should pass the maximum flow required (plus desired safety factor) at the available pressure drop. Choose a linear plug, in general.

When the control valve is in series with another load, and 6 per cent over design flow is sufficient to meet peak requirements, size the valve for twice design flow with a pressure drop of 15 per cent of total available head loss, and be sure the 15 per cent is there for the valve to use at design conditions. If 6 per cent excess is not sufficient, more than 15 per cent pressure drop must be provided for the valve, as otherwise increased valve size will increase capacity only a trifle. Use, in general, a logarithmic plug. Remember that in the series problem the valve is a fixed source of power loss at low flows.

To avoid the loss of economy in the series circuit, remove the control valve from the line and substitute an auxiliary

device such as a governor, an unloader, or an automatic clutch, to modulate the energy input. The trend is toward this type of control because reserve power is available with good economy. Magnetic and hydraulic clutches will become prominent in order to provide turndown for constant-speed electric motors and two-stroke gas engines.

Coal Hydrogenation

THE following six papers, contributed by the Petroleum Division, and presented at the 1949 ASME Petroleum Mechanical Engineering Conference, appear in the May, 1950, issue of Transactions of the ASME. Since the papers are so closely related, they will be available only through purchase of the Transactions at $1 per copy to ASME members and $1.50 per copy to nonmembers. Individual pamphlet copies will not be available for sale.

The Coal-Hydrogenation Demonstration Plant at Louisiana, Mo., by J. A. Markovits, Bureau of Mines, Louisiana, Mo. 1949 ASME Petroleum Mechanical Engineering Conference paper No. 49—Pet-3.

This 200 to 300-barrel per day capacity demonstration plant hydrogenates coal at 700 atm pressure in two stages. First, coal paste is liquefied with finely divided iron catalyst at 525 atm hydrogen partial pressure, then the middle oil distillate is further hydrogenated in the vapor phase on fixed catalyst beds. The hydrogen is made by catalytic reforming of natural gas with steam.

Construction of this plant was completed in January, 1949, but partial test runs were under way by November, 1948.

The plant produced the first synthetic liquid fuels from lignite derivatives in April, 1949.

The plant was designed and built by the Bechtel Corporation of San Francisco, Calif., under technical direction and supervision of the Bureau of Mines. In the plant 10,000-psi operating pressures are combined with temperatures up to 1000 F and the materials to be processed at these conditions range from gases to mixtures of viscous liquids containing high percentages of abrasive solid particles. These service conditions presented many engineering problems of an unusual nature.

This paper describes the process as it is practiced in the coal-hydrogenation demonstration plant.

High-Pressure Vessels in Coal-Hydrogenation Service, by J. T. Donovan and J. A. Markovits, Bureau of Mines, Louisiana, Mo., and M. Josenhans, Koppers Company, Inc., Louisiana, Mo. 1949 ASME Petroleum Mechanical Engineering Conference paper No. 49—Pet-6.

The 200-barrel per day demonstration plant required reaction vessels of 32-in. ID × 39 ft 1½ in. length. The vessels were sized to provide adequate residence time, proper space velocity, and complete accessibility upon removal of the top and bottom heads. To utilize a low-alloy steel it was desirable to keep the shell temperature as low as 500 F. This was accomplished by providing a 3-in-thick asbestos-cement liner separating the reaction space from the shell.

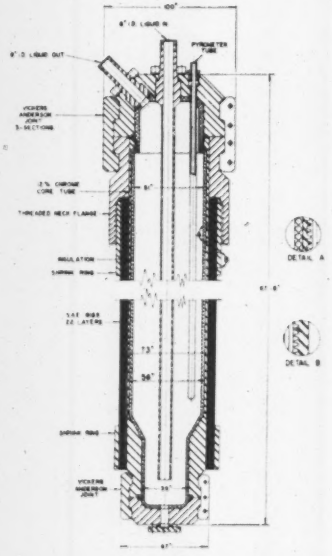
Manufacturers of high-pressure vessels proposed the following three different types of construction for this service:

1 A laminated wall of perforated carbon-steel plates with a 12 per cent chrome-alloy liner.

2 A two-layer compound cylinder with a perforated carbon-moly jacket over a 3 per cent chrome grooved inner shell.

3 A simple cylinder or solid wall forging of 3 per cent chrome.

The three different designs are compared, and the vessels accepted for the plant are described in detail. A German spirally wound construction is also discussed, and its expected advantages are enumerated.



LAYOUT OF FULL-SCALE PLANT CONVERTER USING SPIRALLY WOUND PRINCIPLE

High-Pressure (10,300 Psi) Piping, Flanged Joints, Fittings, and Valves for Coal-Hydrogenation Service, by J. H. Sandaker and J. A. Markovits, Bureau of Mines, Louisiana, Mo., and K. B. Bredtschneider, Koppers Company, Inc., Louisiana, Mo. 1949 Petroleum Mechanical Engineering Conference paper No. 49—Pet-2.

The coal-hydrogenation demonstration plant required large quantities of 10,300-psi piping, flanged joints, fittings, and valves of various types. Service conditions introduce unique problems which have to be considered in the design of these elements. Some of these problems are touched upon briefly, and resulting designs are described.

At this time it appears probable that most piping in future coal-hydrogenation plants would be made lighter by the use of higher-strength steels. However, the other piping components are unlikely to be radically changed in design.

A study was made of several types of flanged joints. Fortunately, data on the lens ring joint used in Germany were available for comparison with conventional types. This was finally chosen as the one having most of the desirable characteristics.

Fittings are limited to tees, 90-deg ells, and reducers, and all are forged and bored. Ells are made by bending straight forged and bored pieces.

In general, shutoff, throttling, check, and relief valves are used. All bodies are forged steel.

All valves are angle type, except for a few vertical-lift check valves, which are straight-through type. The smaller sizes of shutoff and throttling valves are direct hand-wheel-operated and have screwed packing-gland nuts, while larger sizes, 1½-in. and above, have bolted flanged packing glands and are spur-gear- and hand-wheel-operated. Valves are so arranged that the pressure will be above the disk when closed.

Instrumentation for Coal-Hydrogenation Service, by G. L. Bruno and F. W. Geyer, Bechtel Corporation, Louisiana, Mo., and J. A. Markovits, Bureau of Mines, Louisiana, Mo. 1949 ASME Petroleum Mechanical Engineering Conference paper No. 49—Pet-4.

The coal-hydrogenation demonstration plant includes nearly all types of instruments found in normal refinery practice. The instrumentation is not typical of that required in a commercial plant, as many measuring devices were installed for ex-

perimental purposes to gather operating data and to accommodate changes in operation with various types of coal. This paper covers only high-pressure instrumentation with emphasis given to unusual items, new developments, and adaptations; it is discussed in the order of temperature, pressure, flow, differential pressure, level, and miscellaneous instruments.

Measurement and control in high-pressure services is not new. However, when applied to coal hydrogenation, other factors complicate the problem. In addition to pressures of 700 atm there are temperatures of 1100 F, high-viscosity erosive liquids containing up to 50 per cent solids, hydrogen, and mixed hydrocarbon vapors, as well as severe pressure drops of as much as 675 atm, and freezing weather.

The necessity for protection against the hazards of the process established the basis of design for the control center. The control house is a reinforced-concrete building 34 ft × 90 ft, with a solid 12-in. wall on the north or stall side as further protection. Directly outside the wall are located principal control valves and by-pass valves, the handles of which extend through the wall and panel board and are located directly under their respective instruments for manual operation. The instrument board, containing 121 instruments, consists of 30 control panels and 2 annunciator panels, with 18 panels on the north wall and 7 on each wing. The instruments are either pneumatic or electric receivers, eliminating explosive gases or high-pressure liquids from the control room. High-pressure controllers are on the north wall, with miscellaneous recorders and the annunciator system on the wings. High-pressure controls operate either automatically, remote pneumatically, or manually from the center.

Metallurgical and Fabrication Considerations in the Coal-Hydrogenation Demonstration-Plant Construction, by B. H. Leonard, Jr., G. D. Gardner, and J. A. Markovits, Bureau of Mines, Louisiana, Mo. 1949 ASME Petroleum Mechanical Engineering Conference paper No. 49—Pet-5.

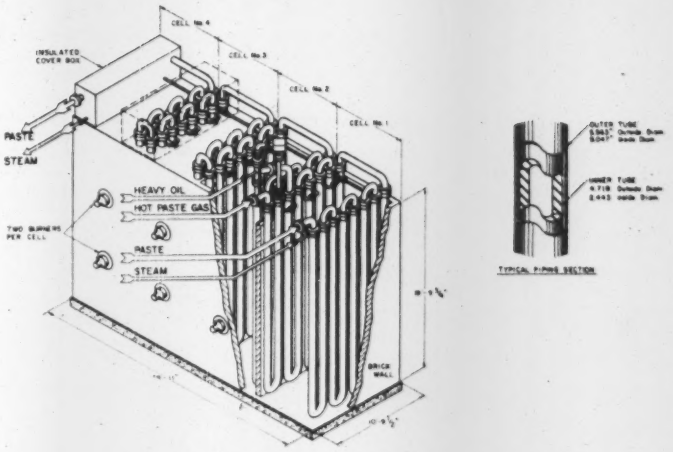
Special equipment, special steels, and heavy wall thicknesses are required to handle hydrogen and abrasive pastes at the high pressures and temperatures of coal hydrogenation. Some metallurgical and fabrication problems pertaining to this specialized process are discussed in this paper.

The preceding papers described the coal-hydrogenation plant. An attempt is made here to show why certain materials were used and to point out some of the fabrication difficulties that were experienced. This discussion is necessarily limited to materials and equipment used for high pressures.

The primary consideration in the choice of materials for various services is the effect of hydrogen at different temperatures. From German and English experience in the hydrogenation field it was learned that carbon steels resisted hydrogen attack at a pressure of 10,300 psig up to a temperature of 375 F. Chromium steels in excess of approximately 6 per cent Cr were found to be hydrogen-resistant at higher temperatures. At these higher temperatures, however, creep strength also must be considered. Above 800 F straight chromium steels do not have high enough creep strength for the service conditions. These factors led to the establishment of three temperature classifications: 0 to 357 F for carbon steel, 376 to 850 F for intermediate chromium steel, and 851 to 1000 F for chromium nickel stainless steel.

Design of Preheaters and Heat Exchangers for Coal-Hydrogenation Plants, by P. W. Laughrey, W. I. Gwillim, J. A. Markovits, Office of Synthetic Liquid Fuels, Bureau of Mines, Louisiana, Mo., and H. Schappert, Koppers Company, Inc., Louisiana, Mo. 1949 ASME Petroleum Mechanical Engineering Conference paper No. 49—Pet-1.

An important step toward improving the economic aspect of the coal-hydrogenation process is to achieve high thermal efficiency. Various means have been suggested for obtaining a high thermal efficiency. Full utilization of the exothermic heat of reaction through an efficient heat-recovery system and proper preheater design becomes important in achieving this goal.



ISOMETRIC DRAWING OF THE PASTE PREHEATER

The function of a liquid-phase preheater is to raise the temperature of the coal paste-hydrogen mixture at 10,300 psi pressure from 250 F inlet temperature to about 815 F before the mixture enters the converters. A radiant-type preheater, therefore, is used in the vapor-phase hydrogenation demonstration plant. This preheater is gas-fired, contains 30 1¼-in-ID, type 316, stainless-steel horizontal tubes arranged in two parallel streams, and has a design duty of 1,890,000 Btu per hr. Feed to the preheater consists of middle oil from the liquid-phase operation (620 F end point), and recycle oil from the vapor-phase distillation, which together with hydrogen comes from the product-feed exchanger with a temperature of about 780 F to the preheater. The preheater superheats the oil vapors to reaction temperature or to about 900 F.

There are 40 heat exchangers in the plant. Thirty-one exchangers are designed for low-pressure service in the distillation and storage areas. Nine exchangers are designed for 700 atm operation in the liquid and vapor-phase hydrogenation. All except the heavy-oil let-down cooler are double-pipe exchangers and only two of these high-pressure exchangers service process streams with the full 10,300 psi in both

tubes. The wall thickness of the inside tube in these two exchangers is only 8 gage. It is designed for a differential pressure of 2000 psi so that testing and starting has to be done with both tubes under pressure. The other high-pressure exchangers are designed with full 10,300 psi operating pressure on the inside tube, the outside tube consisting of a low-pressure tube jacket in which either cooling water or low-pressure oil is flowing. The tube jackets are constructed of carbon steel and the high-pressure tubes of 8 to 10 per cent chrome and $^1/_2$ per cent molybdenum alloy. The heavy-oil let-down cooler is a forced-draft air cooler with eight hairpins, made with Croloy-9M tubes, 30 ft long and 1 in. ID, connected in series flow. The cooling air passes downward at 58 fps through a 64-in. × 10-in. rectangular duct enclosing the hairpins.

Furnace Performance Factors

Methods and Instrumentation for Furnace Heat-Absorption Studies: Temperature and Composition of Gases at Furnace Outlet, by Paul Cohen, Mem. ASME, R. C. Corey, Mem. ASME, and J. W. Myers, Bureau of Mines, Pittsburgh, Pa. 1948 ASME Annual Meeting paper No. 48—A-161 (in type; published in full in Trans. ASME, Nov. 1949, page 965).

As part of the general program of investigations by the ASME Special Research Committee on Furnace Performance Factors, the Combustion Research Section of the Bureau of Mines is making a series of determinations of furnace heat absorption of representative pulverized-coal-fired boiler furnaces. During the course of these studies, modifications have been made in the test technique to improve the precision of furnace testing. Automatic recording instruments have been employed, which permit more detailed sampling and examination of furnace-outlet gases than heretofore, without an appreciable increase in the time or work required. Improved designs of radiation shields have been developed for high-velocity thermocouples with accuracy comparable to the B&W multiple-shield high-velocity thermocouple, but which may be employed conveniently in pulverized-coal-fired furnaces. Detailed descriptions are presented of the distribution of gas composition and temperature at the outlet of a 640,000-lb per hr horizontally fired boiler furnace. Based upon this knowledge, the sampling characteristics of the gases at the furnace outlet for furnace heat-absorption measurements have been examined, and a procedure is suggested for the rational selection of simplified sampling schedules. The methods of calculating furnace heat absorption from the temperature and gas-composition data are examined critically with special emphasis on the effect of weighting with respect to mass velocity. Suggestions are presented whereby the significance of mass velocity for furnace heat-absorption calculations may be determined from the temperature and gas-composition data.

Boiler Feedwater Studies

Corrosion-Erosion of Boiler Feed Pumps and Regulating Valves at Marysville, Second Test Program, by J. M. Decker, Jun. ASME, H. A. Wagner, Mem. ASME, and J. C. Marsh, The Detroit Edison Company, Detroit, Mich. 1948 ASME Annual Meeting paper No. 48—A-118 (in type; published in full in Trans. ASME, Jan. 1950, page 19).

Corrosion-erosion tests at 320 and 385 F indicated that, at these temperatures, carbon steel is attacked to a lesser extent than at 250 F, whereas the reverse is true of the chromium-bearing steels. However, the rate of attack of the chromium steels is still only a fraction of that of carbon steels, so that use of the alloy steels for boiler-feed-pump parts is warranted at the higher temperatures also. Increasing the pH of the feedwater from 7.6 to 8.4 doubled the corrosion-erosion attack on carbon steel in the Marysville boiler feedwater at 250 F, as compared with previous tests at the lower pH. Of two bronzes tested, Navy M material appeared satisfactory at temperatures up to 320 F; a leaded bronze was unsatisfactory at all test temperatures in this program.

Industrial Instruments

Heat-Conduction Errors in Temperature Measurements, by L. E. Smith, The Bristol Company, Waterbury, Conn. 1949 ASME Spring Meeting paper No. 49—S-35 (in type; published in full in Trans. ASME, Jan. 1950, page 71).

In practical applications of temperature measurements where the temperature-sensitive bulb assembly is fastened rigidly to a containing vessel, heat-conduction errors must be considered in order to determine the accuracy of the indicated or recorded temperature. This paper presents for various thermometer-bulb assemblies, the experimental magnitude of the heat-conduction error possible in a medium with a low heat-transfer coefficient (air), and in a medium with a high heat-transfer coefficient (water). The effect of heat-conduction error on the over-all response in simulated practical installations is discussed. It is shown that comparative information on response action of any type of temperature-sensitive element necessitates careful considerations of the condition of attaching the element to a wall or vessel, where heat-conduction effects are present.

ASME Transactions for April, 1950

THE April, 1950, issue of the Transactions of the ASME contains the following:

History and Performance of the Oil-Refinery Steam-Electric Generating Stations of the Pacific Gas and Electric Company, by V. F. Estcourt. (49—SA-11)

Steam-Electric Power Expansion in Southern California, by W. L. Chadwick. (49—SA-16)

Postwar Planning for Steam Capacity in Northern California, by C. C. Whelchel and W. R. Johnson. (49—SA-10)

The Design of Sewaren Generating Station and No. 1 Unit at Essex Station, Public Service Electric and Gas Company, by F. P. Fairchild. (49—SA-15)

Operating Characteristics of the 100,000-Kw Essex Turbine Generator, by Stanford Neal and V. S. Renton. (49—SA-28)

Heat-Rate Test Results of the 100,000-Kw Essex Turbine Generator, by V. S. Renton and Stanford Neal. (49—SA-19)

Frictional Characteristics of O-Rings With a Typical Hydraulic Fluid, by L. E. Cheyney, W. J. Mueller, and R. E. Duval. (48—A-64)

Strength-Variance Studies of Plastics, by W. J. Gailus, Steven Yurenka, and A. G. H. Dietz. (49—F-33)

Theoretical Considerations on the Optimum Adjustment of Regulators, by P. Hazebroek and B. L. van der Waerden. (49—IIRD-1)

The Optimum Adjustment of Regulators, by P. Hazebroek and B. L. van der Waerden. (49—IIRD-2)

The Exhaust-Heated Gas-Turbine Cycle, by D. L. Mordell. (49—F-6)

Properties and Characteristics of Fuel Oils for Industrial Gas-Turbine Usage, by D. P. Heath and E. Albat. (49—F-8)

Combination of Heat Sources and Sinks by the Method of Superposition, by F. H. Bridgers. (49—F-13)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Isotopes as Tools of Engineering

COMMENT BY J. T. BURWELL, JR.[1]

At the Massachusetts Institute of Technology we have been using radioisotopes to study the fundamental mechanism in the phenomenon of dry friction. By means of this very powerful and sensitive tool we were able to demonstrate conclusively that a very small but finite amount of material is always transferred from one surface to the other when two solid bodies rub together. The method is as described by Mr. Aebersold[2] and has been applied both to experimental friction specimens and to piston rings and cylinders.

Proof of the existence of the transfer of material between rubbing surfaces is important since it shows fairly conclusively that friction, at least between metal surfaces, is due in large part to numerous minute adhesions or "welds" which are continually being formed and broken as sliding takes place. The force to overcome friction is the force necessary to shear these welds. This conclusion is aiding us in further understanding and controlling friction.

In the case of a radioactive piston ring rubbing up and down in an engine cylinder, the pattern of ring material transferred and left adhering to the cylinder wall after the engine has been run is shown in the accompanying Fig. 1, taken in the manner described by Mr. Aebersold. In this picture the white spots are the particles of ring material which in this case was chromium from a chromium-plated ring. The top and bottom of the travel of the three rings are clearly visible and the density of transferred material is seen to be greatest at the top of the stroke, probably because there is least lubricant in this region.

This work has been carried out under the sponsorship of the National Advisory Committee for Aeronautics and the Chrysler Corporation and is being reported more fully elsewhere.

[1] Associate Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

[2] "Isotopes as Tools of Engineering," by P. C. Aebersold, MECHANICAL ENGINEERING, vol. 71, December, 1949, pp. 987–990 and 1031.

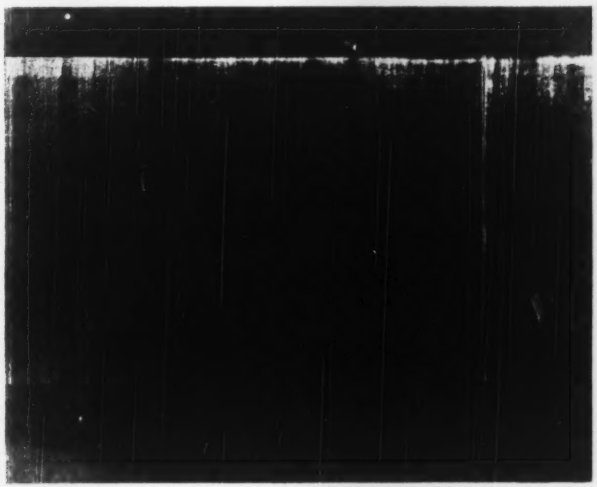


FIG. 1

Engineers in Community Affairs

TO THE EDITOR:

At various times in the publications of our Society and elsewhere I have urged upon engineers and scientists the importance of taking a hand in community affairs as one means of acquiring a social consciousness and competence as contrasted with the purely technical. The early training for life as a citizen seemingly must become an essential part of the education of professional technicians in schools and colleges. Without some indoctrination in the relatively small affairs which constitute community life any effort toward participation in politics may be a disillusioning experience.

Recent correspondence affords definite indications of the very tenuous connection between our profession and certain institutions of the character which make up our community life.

For instance, no engineers or scientists are to be found among the 24 directors of the Indian Rights Association, or the 64 directors of the American Association for the United Nations, or the 25 directors of the Brandywine Valley Association, or the 33 directors of the Foreign Policy Association, or the 26 members of Collier's magazine committee for the annual award of its Congressional medals. Among those guiding the following agencies there appears only one engineer or one scientist in each case: 31 members of the Board of the Institute of International Education (Arthur H. Compton, physicist), 33 supporters of President Hoover's recent elaborate report on the reorganization of the Federal Government (Governor Charles Edison, engineer), the 66 sponsors of the Public Affairs Institute (the author), the 100 members of the Board and National Committee of the National Civil Liberties Union (the author), the 66 directors of the Philadelphia World Affairs Council (William L. Batt, engineer).

Has the ambition to rate well as technicians for economic and other reasons led us to narrow our lives by ignoring citizen responsibilities and opportunities?

Any such attitude whether by individuals, groups, or professions is not likely to attract public esteem.

MORRIS LLEWELLYN COOKE.[3]

Heat Transfer

TO THE EDITOR:

The writer feels honored that his book[4] has been reviewed by Professor Lucke in such detail. However, overlooking "one" letter seems to have given him an erroneous impression of what is planned in Vol. II. Part G will deal with "Selected Fields of Application," the underlined letter *s* being missing in Dr. Lucke's review. This part will include most of what the reviewer regrets to be omitted. For instance, separate chapters will be devoted to the various sorts of heat exchangers, particularly, recuperators and regenerators, to furnaces, thermal machinery, and other fields of application, including a considerable number of practical tables and charts.

Probably Professor Lucke also overlooked the following passage in the preface: "Finally the combination of the different modes will be shown for selected topics of practical application, such as thermometry and heat exchangers. This ... will be presented in a second volume ..." Combination means overall heat transfer.

Originally the writer had planned to call the first volume "Fundamentals," and the second one "Applications." Only, for practical reasons, some of the applications, as extended surfaces, were included in the first volume, and a part of the fundamentals (geometry of radiation and gas radiation) had to be taken into the second volume.

MAX JAKOB.[5]

[3] Fellow ASME.

[4] "Heat Transfer, Vol. I", Reviews of Books, MECHANICAL ENGINEERING, vol. 72, Feb., 1950, pp. 168–171.

[5] Research Professor of Mechanical Engineering, Illinois Institute of Technology and Armour Research Foundation, Chicago, Ill. Mem. ASME.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

National Transportation Policy

NATIONAL TRANSPORTATION POLICY. By Charles L. Dearing and Wilfred Owen. The Brookings Institution, Washington, D. C., 1949. Cloth, 6 × 9 in., tables, charts, xiv and 459 pp., $4.

REVIEWED BY L. W. WALLACE[1]

THIS book fully sustains the high-standards characteristics of the studies and publications of The Brookings Institution. It will be quoted in Congressional hearings and debates and also in the daily, trade, and technical press. It is of great value to those having responsibility with respect to any phase or type of transport and the formulation and administration of related national policies.

The authors are members of the staff of The Brookings Institution. They directed the Hoover Commission "Task Force on Transportation." The book is largely based upon the findings of the task force.

The book consists of three parts.

Part 1 describes the types of transportation facilities that are constructed, maintained, and financed by the national government; how the government is organized for this purpose; and how transport programs are financed. Consideration is also given to the special problems of national defense.

Part 2 analyzes the government's regulatory functions. The varying objectives of regulatory action and the administrative devices used in the attempt to achieve these goals are described and the major issues of public policy are defined.

Part 3 is a general summary. It includes an evaluation of national transportation policy and specific recommendations for revision of policy and administrative organization.

Three appendixes contain a large body of current important information.

The authors made such arresting statements as these: "The financial position of the majority of carriers is weak despite near record levels of peacetime traffic. The emergence of less favorable economic conditions would make the outlook for railroad modernization and the financial health of the air-transport industry even less promising. The present situation is particularly adverse from the standpoint of national defense and the survival of private ownership of transport enterprises."

"The transportation problem is traceable largely to the fact that Congressional policies have failed to keep pace with transportation requirements as influenced by revolutionary changes in transport technology during the past three decades. These changes," say the authors, "have resulted in the transportation problem shifting from one of controlling monopolistic abuses to one marked by intense competitive struggle among railroad, highway, water, and air transportation enterprises.

"Private management has aggravated the problem through ill-advised expansion, failure to achieve maximum economy, and lack of alertness to the possibilities of the newer forms of transportation.

"Local communities and other interested groups have multiplied the difficulties by tenaciously resisting the abandonment of obsolete plant and services."

The authors point out that Federal transportation responsibility is so widely and vaguely divided that one branch of the government may nullify the actions of another, and conclude that sound economic conditions and maximum technological progress can be realized only through a unified national transportation policy and the necessary organization to administer the policy. Only in this way, say the authors, can there be eliminated the contradictions and inequities of dealing with each form of transportation separately.

They therefore propose a Department of Transportation, under a secretary of cabinet rank, and an independent Transportation Regulatory Commission.

The findings of the authors are expressed in the following quotations:

"Dependence of a progressive society on adequate transportation is demon-

[1] Counselor on Management, Cincinnati, Ohio. Mem. ASME.

strated by the extraordinary development and use of transport facilities in the American economy.

"The nation's transportation system, composed of railroad, highway, pipe-line, water, and air facilities, is the product of a unique joint undertaking. Private enterprise has supplied much of the inventive genius, the production technology, and the managerial drive that have given direction and impetus to the development of the newer forms of transportation. And, until recently, the private investor has furnished the bulk of the capital required to finance experimentation, the launching of new enterprises, and their subsequent expansion. Public enterprise, on the other hand, has supplied a substantial part of the basic facilities over which private equipment has operated, and has participated in a number of ways in the transport revolution.

"But the fundamental differences among the several methods of operation and the joint responsibilities of government and private industry have likewise created a highly complex and difficult system to manage.

"The development of our transportation plant has continued to the point where effective and almost universal competition has supplemented monopoly.

"The full significance of national policy is measured not simply by federal action itself, but by the influence of federal action on the grand total of transportation expenditures. The policies which govern federal activity in the promotion and regulation of transportation are major factors in determining the size of the transportation bill, and how it is incurred. They influence to an important degree the price and quality of transportation from service, the allocation of traffic, and the pattern of transportation investments. And since transportation is one of the principal means by which the resources of the nation are developed and the products of the economic system utilized, it is clear that the impacts of federal transportation policy extend to almost every phase of the nation's economic life.

"A large number of government agencies participate in federal promotional and regulatory functions. For the fiscal year 1949 these activities involved a billion dollars in federal appropriations; and 93,000 persons were employed in carrying out the work. Some of these agencies are concerned exclusively with transportation matters, generally with one particular form of transportation, while others may perform services which are utilized in significant degree by the transportation industries."

Recommendations of the authors include:

(*a*) A Department of Transportation, to consist of: Office of Water Transportation; Office of Civil Aviation; Office of Highway Transportation; Office of Railroad Transportation; Office of Secretary of Transportation (of cabinet status). The proposed powers, duties, and internal organization are fully discussed.

(*b*) A Transport Regulatory Commission as an independent agency. The proposed powers, duties, and internal organization are fully discussed. It is proposed that this Commission have jurisdiction over: (1) All the major functions performed by the Office of Public Roads, Civil Aeronautics Administration and the Maritime Commission; (2) the policy functions of the Army Corps of Engineers; (3) all operating functions for air, rail, and motor transport which are presently performed by independent regulatory agencies; (4) the Coast and Geodetic Survey; and (5) the regulatory authority presently dispersed among the Interstate Commerce Commission, the Civil Aeronautics Board, and the Maritime Commission.

The Hoover Commission Report

THE HOOVER COMMISSION REPORT on Organization of the Executive Branch of the Government. McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Can., and London, England, 1949. Cloth, 5¾ × 9 in., charts, 1 plate, xvi and 524 pp., $3.50.

REVIEWED BY E. P. VANDERWICKEN[2]

WHEN things go from bad to worse there is something like a natural law that dictates that men, and particularly their latent power of reason, will respond to unselfish direct statement of facts and logical remedies. It is reliance upon this human virtue that gives us hope and courage.

This may explain why the Hoover report on Organization of the Executive Branch of our Federal Government was conceived of and why its acceptance has been so general. It is an honest and unselfish attempt to cut through a dense growth of underbrush to determine what is true and good in the jungle of federal executive administration. Years of unprecedented expansion and, perhaps, inability to reorganize under the pressure of events, left us with a maze of executive organization, personnel, and expenditures which was all but uncontrollable. The Executive Branch comprised 1141 separate parts. Personnel had risen from 563,805 to 3,749,578 in a few years.

President Truman had presented proposals for reorganization which were minor patchwork and did not achieve basic improvement. Three of his seven proposals were rejected. Finally a Commission on Organization of the Executive Branch was authorized by Congress to recommend means for limiting expenditures; to eliminate, consolidate and abolish services, activities and functions; and to define and limit executive functions.

[2] Secretary and Treasurer, York Corporation, York, Pa.

It would be impossible to summarize a reference work such as this study but it is easy to evaluate its significance.

About one fifth of the recommendations have already been adopted. The most important yet to be adopted cover budgeting and accounting reform, personnel management, and post-office reorganization. Even now, this study can be recorded as initiating one of the few significant advances ever made in the art of government administration in this country.

The study will be for many readers a case study in principles that are applicable to any organization. The businessman might well review the findings of the Commission and apply the principles to his own business.

For the student of government it is a blueprint for improvement.

For every citizen it is a monument to the value of independent fundamental study and thinking on important public problems. It is to be hoped that the technique will be used more frequently and that the caliber of other commissions will be comparable.

The recommendations of the Commission are grouped under:

1 "General Management" which seeks to apply well known, basic principles of good organization to the executive department hodgepodge.

2 "Personnel Management" in which generally accepted advances in techniques of pay policy, recruitment and placement, separations, and other matters are applied.

3 "Office of General Services" in which supply activities of the government are studied.

4 "The Post Office."

5 "Foreign Affairs" which includes some sensible and urgent recommenda-

tions to improve the organization and clarify the objectives of the State Department.

6 "Department of Agriculture," especially its organization.

7 "Budgeting and Accounting" which recommends "that the whole budgetary concept of the Federal Government should be refashioned by the adoption of a budget based upon functions, activities and projects."

Other important and basic changes are urged.

8 "The National Security Organization."

9 "Veterans Affairs"

10 "Department of Commerce"

11 "Treasury Department"

12 "Regulatory Commissions"

13 "Department of Labor"

14 "Department of Interior" and five other Sections.

Problems in Personnel Administration

PROBLEMS IN PERSONNEL ADMINISTRATION. By Richard P. Calhoon. Harper and Brothers, New York, N. Y., 1950. Cloth, 5½ × 8¼ in., xii and 540 pp., $5.50.

REVIEWED BY EDWARD H. HEMPEL[3]

THE recent appearance of quite a few books which present personnel administration in its entirety, is undoubtedly caused by the desire to incorporate techniques and improvements applied during World War II, and by the intention to create an up-to-dateness in this subject which would be helpful to teachers, students, and practitioners alike.

To the careful observer of management this gives an opportunity to compare the latest with the previous status of the art and thus to appraise what kinds of contributions to the progress of mankind can be expected from personnel administrators in the future. In general the new books do not show much that would be new or much better, they mostly show only more of what there was.

"Problems in Personnel Administration" is different from the other texts in so far as it aims not only to present but also to appraise and improve the attitudes, policies, and techniques which were and still are commonly in use. The appraisals and evaluations of the subjects are based on a survey and opinion sampling procedure which covered more than five hundred companies.

The critical approach is definitely a sign of progress, since in personnel administration it never happened that any doubts arose on anything being wrong or imperfect. The attitude expressed in the book is possibly the first move to shake up a kind of thinking and acting which had become stale, set, and entirely too tolerant and inefficient to make the personnel administrator a real working member of the management team. It was due to these shortcomings that the personnel director of most companies never became more than a second or third-rate auxiliary to top management, and that he had to remain on the defensive instead of becoming a full-fledged contributor to company progress and the creator of truly good employee relations.

The first four chapters of the book show clearly the author's attempt to give new ideas which would overcome the aversion of top and line managers to nonproductive personnel work, and wisely he points out those steps and attitudes that would help to obtain for personnel administrators and their programs more respect and support.

In chapter 5 the author criticizes most strongly the common shortcomings of Employment Interviewing and many a vice-president or director of personnel might well read up on what the author has to say and mend his own ways of choosing personnel.

In the next fifteen chapters the numerous techniques and methods which form the practices and routines of personnel work are gone over one for one. The bad ones are criticized and improvements are suggested. Selection and Induction, Employee Training, Supervisory Training, Wage and Salary Administration, Work Load, Safety Administration, Problems of Job Status, Grievance Handling, Labor and Social Legislation, Collective Bargaining, and related subjects, all are dealt with.

The numerous problems that are provided are obviously for students, as are the projects, and last but not least the demonstrations, which means playlets to be enacted by the prospective PhDs who are to play the roles of personnel directors, plant managers, national union representatives, shop committee members, employees, supervisors, interviewers, superintendents, presidents of various companies, foremen, or applicants in different suggested situations in all kinds of industries and even in department stores.

Of the entire text these parts are the weakest. They are open to doubt and even ridicule, and as assignments they are hardly in line with the amounts of effort and knowledge which are required in other branches of industrial training from graduate students in engineering, for instance. The students may well learn in these impersonations the arts of improvising, imagining, guessing, arguing, supposing, and similar mental facilities, but hardly will this help to gain for personnel administration that concrete factual-convincingness which it needs to achieve equality on the management team and to direct the fate of all employees who are the most important factor in any company.

The problems *of* personnel management, are quite different from and much more serious than the problems *in* personnel administration. They are still left in the hands of the line managers, where most of the life issues concerning personnel have been muffed, solved wrongly, or by reliance on lawyers, consultants, politicians, authorities, mediators, arbitrators, and other go-betweens. Personnel administration can become effective management only when its scope and training will aim to turn out personnel men who can effectively cope with and eliminate the steadily growing number of nonproductive middlemen, agencies, bureaus, offices, and legislative makeshift arrangements which separate ever more widely the management from its own men and workers.

Clearly, the evaluation of personnel work and procedures will help to make this kind of knowledge better, but much more appraisal and improvement seems to be needed until possibly someday the art of dealing with personnel will become a more exact and solidly founded science.

[3] Adjunct Professor of Industrial Engineering, Graduate School, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Chairman Small Plant Committee ASME. Mem. ASME.

Depreciation

DEPRECIATION. By Eugene L. Grant and Paul T. Norton, Jr. The Ronald Press Co., New York, N. Y., 1949. Cloth, 6 × 9¼ in., 25 figures, 35 tables, Appendixes, Bibliography, Problems, Index, xii and 472 pp., $5.

REVIEWED BY J. K. LASSER[4]

DEPRECIATION is like the weather. No one is satisfied with it; no one has yet been able to suggest a change that will satisfy extended criticism of current tax laws and current tax practices.

Much of the difficulty being experienced concerning basic objectives is due to lack of agreement among engineers, accountants, businessmen, and governmental agencies. In recent years have

[4] Certified Public Accountant, J. K. Lasser and Company, N. Y.

come many excellent discussions of certain aspects of depreciation.

But this book, by two distinguished authorities on the subject, is the first attempt (1) since high tax rates and (2) the change in Treasury practices to do this: develop the fundamental theory of depreciation; show how different our present practice is from what it is generally supposed to be.

Here are stressed the economic and social aspects of depreciation—plus the dangers in trying to improve present practice solely through a consideration of accounting and tax aspects. Simultaneously, there is full recognition that with high tax rates, business decisions involving investments in depreciable assets must be made with one eye on the tax collector. So a very large part of the book is directed specifically at depreciation for accounting and tax purposes.

The book is divided into four parts. Part 1, on Some Fundamental Concepts, contains three chapters which discuss such matters as the importance of depreciation to business and government, the various meanings of depreciation, and reasons for decrease in value and property retirement.

Part 2, on The Treatment of Depreciation for Accounting and Income Tax Purposes, has eight chapters on such matters as the basic concepts of orthodox depreciation accounting, the statistical approach to estimates of average service life, various depreciation-accounting methods (with particular emphasis on the item and group straight-line methods) plus a lengthy and interesting historical discussion of the development of the treatment of depreciation in federal income taxation in the United States.

Part 3, on Some Business Problems Related to Depreciation Accounting, consists of five chapters on the making of engineering-economy studies when acquiring or retiring assets or measuring the disadvantages of old assets as compared to new ones, the conservation of capital, and the financing of asset replacements, some problems created by price-level changes, and finally a very important chapter on the uses and limitations of depreciation accounting as a guide to business decisions.

Part 4, on The Public Viewpoint, has two chapters covering the public interest in the accounting and income-tax treatment of depreciation, the proposals for improving the accounting and income-tax treatment of depreciation, and finally, the recommendations of the authors for changes in present practice.

The book also contains six highly useful appendixes, including excerpts on depreciation from the Internal Revenue Code and the income-tax regulations, certain Bulletin "F" composite lives for various industries, brief statements of the principal points at issue in some 45 court cases on depreciation, compound-interest tables and tables giving ratios of book values to first cost with the declining balance method.

Here, too, is a bibliography of some 80-odd items and 32 interesting problems for classroom use when the book is employed as a textbook. These may well be used in self-study by all readers.

The authors have illustrated their points by many interesting examples, charts, and tables—fortunately set into an easy to read, attractive type face.

I think there is general agreement that something must be done to improve present depreciation practice for tax purposes. That is essential if we are to preserve our free-enterprise system, encourage investment in productive assets, and aid new and small businesses to achieve normal growth and prosperity. The Grant-Norton proposals to do that are a most logical basis to improve present practice—with an eye to both the present obstacles to industrial development and the revenue needs of the federal government. As a result, this should be an important book in our current legislative thinking about better depreciation mechanics.

Quite apart from its influence to change chaotic conditions, the book will be highly useful to accountants, engineers, industrial managers, and public officials dealing with the practical problems of depreciation. It particularly should be "must reading" for top-management executives who have the responsibility for making decisions upon capital investments.

Production Processes

PRODUCTION PROCESSES: Their Influence on Design (Vol. 1). By Roger W. Bolz. The Penton Publishing Co., Cleveland, Ohio; London, England, 1949. Cloth, 6¼ × 10 in., 652 figures, x and 568 pp., $10.

REVIEWED BY J. F. DOWNIE SMITH[a]

THIS book is volume 1 of a two-volume series. Much of the material in the book has appeared in the form of articles in *Machine Design*.

The book is largely a primer of production processes, of special importance to one not too familiar with modern machine-shop practices. A few of the processes described will be of distinct interest to designers and machine-shop foremen who have not had an opportunity to keep up to date in modern methods, and such men are constantly growing in numbers.

It may also serve to stimulate activity in many of the smaller and more isolated manufacturing plants. The book could be used as extra reading for college or technical-institute students, especially where such students do not take machine-shop training.

In volume 1, the author has picked out 36 different production processes, each with its own chapter, some quite well known, and others relatively new. He first describes the process, then the machines employed in the process, giving data on the work each can handle. He discusses production-rate possibilities and design features. The author then gives salient points on how parts should be designed to utilize the process satisfactorily, sometimes giving examples of good and bad design practice.

It gives the engineer some help in determining the manufacturing limits and the accuracy he may expect, with each process, and thus he can specify those within reason. It also mentions which materials should or could be used.

The book has 568 pages, and is amply and well illustrated with 652 photographs and drawings. Volume 2 is expected to cover casting, molding, fabricating, and treating and finishing methods.

These two volumes will still not cover all industrial processes, and some judgment had to be exercised as to which to incorporate. The result, in the reviewer's opinion, is a wise choice.

In certain of the chapters there is a limited amount of instruction on the proper design of parts, but what is given is good. Sometimes the information is correct but indefinite, leaving a lot to the designer. Infrequently there is evidence of too quick acceptance of an apparent truth which may be questionable.

A general criticism deals with the lack of comparison among the several processes which may be used for the same article. The engineer and designer would appreciate recommendations as to the preferred method of making an article of a particular design. For example in the book the same general product is shown made by several different processes, each one of them satisfactory, leaving the reader wondering which he should use.

Many of the chapters are quite stimu-

[a] Dean, Engineering school, Iowa State College, Ames, Iowa. Fellow ASME.

lating and would interest most mechanical engineers.

Occasionally the book does not give the designer the specific information he needs to design for a particular process, but it at least acquaints him with the general procedure, so that he could then go to a specialist in that field for the answer. He may get an idea about how to do a job differently than he had previously known.

In industry there is rapid change in manufacturing methods and costs. Frequently, cost estimates of the same part obtained several years apart in the same organization will differ widely, sometimes up and sometimes down. Also there is a constant tendency among engineers toward more complex designs, generally to achieve a better end product. But this involves increased cost, which might be difficult to justify. Thus, a sober weighing of production processes is constantly in order, and this book should serve a useful purpose.

In summary, this is an excellent book for the designer, and for the production man. It may also be of considerable help as supporting information for the mechanical-engineering student.

Books Received in Library

ASTM STANDARDS ON COAL AND COKE, prepared by ASTM Committee D-5 on Coal and Coke, October, 1949. American Society for Testing Materials, Philadelphia, Pa. Paper, 6 × 9 in., 729 pp., illus., diagrams, charts, tables, $2. This booklet brings together all of the ASTM standards on coke and coal. It gives 28 test methods, specifications, definitions of terms, and numerous proposed methods. Coal sampling, analysis for volatile matter in connection with smoke ordinances, grindability, drop shatter test, tumbler test, screen analysis, size, sieve analysis, cubic-foot weight, index of dustiness, and free-swelling are covered for coal and coke.

ASTM STANDARDS ON TEXTILE MATERIALS, prepared by ASTM Committee D-13; Specifications, Tolerances, Methods of Testing, Definitions and Terms, October, 1949. American Society for Testing Materials, Philadelphia, Pa. Paper, 6 × 9 in., 574 pp., illus., diagrams, charts, tables, $4.50. Definitions and terms, methods of testing, and specifications for textile and related materials are given. Additional material appearing in appendixes as information includes tables on basic properties of textile fibers, on yarn number conversion, and on relative humidity.

CREEP OF METALS AND ALLOYS. By E. G. Stanford. Temple Press, Ltd., London, England 1949. Linen, 5½ × 8¾ in., 162 pp., illus., diagrams, charts, tables, 15s. Surveying the published literature on the subject, this book contains a concise account of (1) the technique involved in the measurement of creep, (2) the characteristics of the normal creep curve, (3) the factors which influence creep behavior of metals, (4) the interpretation of creep-test results from an engineering stand-point, and (5) the progress which has been made in the physical study of the mechanism of creep. A bibliography is included.

LA FONDERIE DES ALLIAGES LÉGERS ET ULTRA-LÉGERS. By M. Caillon, preface by M. R. de Fleury. Service de Documentation et d'Information Technique de l'Aéronautique, Paris, France, 1949. Paper, 7 × 10½ in., 224 pp., illus., diagrams, charts, tables, 800 fr. This publication covers in a detailed manner the subject of magnesium-casting practice, including foundry sand, melting practice, casting defects, tapping and pouring devices, and an appendix containing notes on certain special points in the process. There is also a discussion of the collaboration between the research department and the shop necessary for the production of sound, effectively designed castings.

FOURIER METHODS. By P. Franklin. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1949. Cloth, 5½ × 8¼ in., 289 pp., diagrams, tables, $4. This text for engineering students covers harmonic analysis, complex exponentials, Fourier integrals, Fourier transformers, and Laplace transforms. A working knowledge of elementary calculus is assumed, but topics of advanced calculus are developed where needed. Applications to physical problems involving ordinary and partial differential equations are included. There are many sets of practice problems with answers.

GRINDING PRACTICE. By F. H. Colvin and F. A. Stanley. Third edition. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Cloth, 6 × 9¼ in., 419 pp., illus., diagrams, charts, tables, $3.75. This book covers the field of grinding machines and abrasive wheels, showing what they do, how to operate them, how to make best use of them on various types of work, and the advantages in production economy that result from use of the right machines and methods. The numerous changes made in this edition include a rearrangement of material and new data on different phases of grinding practice.

GUIDED MISSILES. By A. R. Weyl. Temple Press, Ltd., London, England, 1949. Paper, 5½ × 8¼ in., 139 pp., illus., diagrams, tables, 7s 6d. This book provides a history of the evolution and principles of guided and directed missiles for military and peaceful purposes. Following chapters on principles, constituents and origins of guided missiles, the development of operational long-range rockets and smaller types of guided missiles is discussed. The appendixes contain data on design characteristics, code names for rocket propellants, and a classification of the belligerent use of guided missiles.

DER INDUSTRIELLE WÄRMEÜBERGANG FÜR PRAXIS UND STUDIUM MIT GRUNDLEGENDEN ZAHLENBEISPIELEN. By A. Schack. Third revised edition. Verlag Stahleisen M.B.H., Düsseldorf, Germany, 1948. Cloth, 6¼ × 9 in., 385 pp., diagrams, charts, tables, 24.50 DM; $7.35. The major part of this book on industrial heat transmission deals in a general manner with the theory of heat transfer by conduction, convection and radiation, and with the calculation of heat exchange. The succeeding chapter demonstrates the application of heat-transmission theory to the solution of actual problems. Tables of thermal conductivities, specific heats, and other useful data are included.

MANUFACTURING ANALYSIS. By R. F. Kipers. Sponsored by American Society of Tool Engineers, published by McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1949. Cloth, 6 × 9¼ in., 452 pp., illus., diagrams, charts, tables, $5. This text is designed to familiarize the student with various processes, machinery, tooling and techniques for the production of consumer goods. It covers assembly methods, devices, and materials-handling equipment. It also presents a study of inspection procedure and quality control. Recent advances in surface-finish analysis, tolerance balancing, and tool estimating are included.

MATERIALS ENGINEERING OF METAL PRODUCTS. By N. E. Woldman. Reinhold Publishing Corporation, New York, N. Y., 1949. Linen, 6¼ × 9¼ in., 583 pp., illus., diagrams, charts, tables, $10. Of interest to writers of material specifications, and metallurgical and mechanical engineers, this book provides information useful for the selection of the type of metal or alloy which is best able to meet a given set of service conditions. Accompanying the text are numerous tables of data on the physical properties and performance statistics of the metals discussed together with illustrations showing various types of metal failures. Four of the five main sections deal with materials for lightweight construction, for mechanical products, for the electrical industries, and for special and severe service; the fifth covers testing and inspection procedure.

METAL CLEANING BIBLIOGRAPHICAL ABSTRACTS (Special Technical Publication No. 90), prepared by J. C. Harris. American Society for Testing Materials, Philadelphia, Pa., 1949. Paper, 6 × 9 in., 68 pp., $2.75. Covering the production, finishing, and maintenance of metal products, this pamphlet contains almost 500 references and abstracts relating to all kinds of metals and most types of processes. Author, subject, and specification indexes are included.

METAL CUTTING TOOL HANDBOOK. Metal Cutting Tool Institute, New York, N. Y., 1949. Cloth, 6 × 9¼ in., 647 pp., illus., diagrams, charts, tables, $6.50. This handbook presents complete and up-to-date information on various types of metal cutting tools, their operation and maintenance. There are sections on twist drills, reamers, counterbores, taps, dies, milling cutters, hobs, gear shapes, cutters, and broaches. Each section contains pertinent data on speeds, feeds, operating conditions, sharpening, and maintenance instructions. There are also tables of commercial sizes of each type. An engineering-data section is also included.

Mitteilungen aus dem Institut für Thermodynamik und Verbrennungsmotorenbau, Nr. 7. ZYLINDRISCHE GLEITLAGER BEI INSTATIONÄRER BELASTUNG. By H. H. Ott. Verlag AG. Gebr. Leemann & Co., Zurich, Switzerland, 1948. Paper 6½ × 9¼ in., 103 pp., diagrams, charts, tables, 10.50 Swiss fr. This analysis of cylindrical plain bearings under unsteady load deals with two main aspects: the calculation of resulting force under a general movement of shaft centers; the path of the shaft centers under loading of the bearings by a small sinusoidal force of constant direction.

NUMERICAL ANALYSIS OF HEAT FLOW. By G. M. Dusinberre. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada, London, England, 1949. Cloth, 6 × 9¼ in., 227 pp., diagrams, charts, tables, $4.50. This book presents in a learnable usable form, modern numerical methods for the calculation of heat flow in solids. These finite-difference methods are free from many of the limitations of conventional differential analysis. Based on material heretofore scattered in the literature, a variety of techniques is included for the

solution of problems whether in the field of steady state or transients.

PATENT TACTICS AND LAW. By R. S. Hoar. Third edition. Ronald Press Company, New York, N. Y., 1950. Cloth, 6 × 9¼ in., 352 pp., $7. Of interest to the engineer, independent inventor, and business executive, this book constitutes a translation into plain English of existent patent law. Particularly noteworthy in this third edition are the changes in the handling of appeals within the Patent Office and new practices based on recent changes in the "Rules by Practice" and "Manual of Patent Examining Procedure" published by the Patent Office. A considerable number of case citations have been added, as footnotes, as well as a glossary of terms relating to patent law.

PREVENTION OF IRON AND STEEL CORROSION, Processes and Published Specifications. Compiled by C. Dinsdale. Louis Cassier Co., Ltd., distributed by Iliffe & Sons, Ltd., London, Birmingham, Coventry, Manchester, England; Glasgow, Scotland, 1948. Cloth, 5½ × 8¾ in., 88 pp., tables, 5s. The object of this book is to provide a complete index of methods, processes and standard specifications relating to the prevention of corrosion of iron and steel. The material is divided into three parts dealing respectively with prevention methods, cleaning metal parts, and codes of practice. An appendix deals with paint and aint-component specifications. Specifications for alloyed iron and steel are not included

PRINCIPLES OF A NEW ENERGY MECHANICS. By J. Mandelker. Philosophical Library, New York, N. Y., 1949. Fabrikoid, 6 × 9½ in., 73 pp., diagrams, charts, $3.75. This book explains this new branch of physical science which represents the next step of an evolution, leading from Newton's classical mechanics through Einstein's relativity theory as an intermediate stage. Part one is devoted to a development and statement of principles, and part two shows how the principles explain physical phenomena.

PRINCIPLES OF RHEOLOGICAL MEASUREMENT, Report of General Conference, Bedford College, University of London, October 1946. By British Rheologists' Club. Thomas Nelson and Sons Ltd., London, England; Edinburgh, Scotland; Paris, France; Melbourne, Australia; Toronto, Canada; New York, N. Y., 1949. Cloth, 6 × 8¾ in., 214 pp., illus., diagrams, tables, charts, 30s. This volume contains 11 papers submitted to a conference of the British Rheologists' Club, together with contributions to the discussions. Divided into four sections, the first is concerned with "soft" materials, particularly with greases, the second treats materials of intermediate consistency, such as rubber, while "hard" materials are discussed in section three. The final section gives the report of the Club Committee on the meaning and use of certain rheological terms.

THERMODYNAMICS OF DILUTE AQUEOUS SOLUTIONS With Applications to Electrochemistry and Corrosion. By M. J. N. Pourbaix, translated by J. N. Agar, with a foreword by U. R. Evans. Longmans, Green and Co., New York, N. Y.; Edward Arnold & Co., London, England, 1949. Cloth, 6 × 9¼ in., 136 pp., charts, tables, $5.50. Of interest to those dealing with corrosion problems, this monograph develops a general method for the calculation of equilibrium conditions in reactions in dilute aqueous solutions. Methods whereby such equilibria can be expressed graphically are also explained and examples of their applications are given. This translation is based on the 1946 French edition. Reference is made in the text to more than 130 articles and books.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, ASME, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the Cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is submitted to the Board on Codes and Standards, as authorized by the Council of The American Society of Mechanical Engineers, for approval, after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of January 26, 1950, and approved by the Council under the date of March 14, 1950.

CASE NO. 989 (REOPENED)

(Special Ruling)

Inquiry: May chromium stainless steels be used in the construction of welded unfired pressure vessels under the ASME Boiler Code rules?

Reply: Chromium steels may be used in the construction of welded unfired pressure vessels in accordance with the rules of Pars. U-68 or U-200 of the Code except that vessels constructed of Type 405 steel and welded with austenitic stainless steel electrodes may also be fabricated in accordance with the rules of Pars. U-69 or U-201. The following limitations shall also apply:

(1) *Material Specifications:* Material shall conform to one of the following specifications:

AISI type no.	Item	Spec. no.	Class or grade
405	Sheets & Plates	SA 240	O
405	Tubing	A268-47	TP 405
410 modified	Sheets & Plates	SA 240	A
410	Tubing	A268-47	TP 410
410 modified	Forgings	SA 182	F 6
410	Castings	A296-46T	10
430 modified	Sheets & Plates	SA 240	B & D
430	Tubing	A268-47	TP 430

Where grades are lacking in the applicable specifications, the desired type of steel may be made to the specification covering the applicable form (tubing, casting, etc.) with chemical and physical properties as specified in SA 240 for the same type of steel.

(2) *Heat-Treatment:* Although a welding preheat of at least 300 F is usually found necessary when welding with ferritic stainless steel electrodes in order to avoid welding cracks, it is not made mandatory since successful results have been obtained without preheat, particularly in the case of light plates. When preheating is employed, the stress relieving heat-treatment specified below should preferably follow without intermediate cooling.

Vessels built to the requirements of Pars. U-68 or U-200, except for vessels of Type 405 steel welded with austenitic electrodes, shall be stress relieved at a temperature of not less than 1350 F nor more than 1450 F. The soaking time shall be of sufficient period to produce satisfactory ductility in the weld metal. Cooling shall be at a rate not higher than 100 F per hour down to 1100 F after which cooling in still air is permitted.

Vessels of Type 405 steel welded with austenitic electrodes and built to the requirements of Pars. U-68, U-69, U-200, or U-201 shall be stress relieved as required by Par. U-76, vessels built to Pars. U-69 or U-201 and having shell thicknesses less than the limits established in Par. U-76 need not be stress relieved.

The test plates shall be heat-treated by the same temperature-time cycle as the vessels they represent.

(3) *Radiography:* All Pars. U-69 and U-201 vessels shall be spot radiographed in accordance with the requirements of Pars. U-208 (a) (b) (d) and (e).

The radiography of Pars. U-68 and U-200 vessels shall be done after the welds have been stress relieved either as an interstage or final heat-treatment of the vessel. The final radiographs of any seam repair weld of such vessels shall be made after the repair has been stress relieved.

(4) *Thickness Limitation:* The Code limitations on thickness shall apply except that the minimum thickness permitted is $^1/_{16}$ in. for noncorrosive condi-

tions of service and $^3/_{32}$ in. for corrosive conditions of service. (See Appendix.)

(5) *Temperature Limitations:* Vessels constructed of Type 430 steel shall be limited to a service temperature of 800 F max.

(6) *Allowable Working Stresses:* The allowable working stresses for all these materials shall be those given in Table U-2 for Grade A of Specification SA-240 until such time as allowable stresses are established for the other specifications and grades.

(7) *Fabrication and Testing:* Fabrication shall be done and weld tests made in accordance with the requirements of the Code, including qualification of the welding procedure used and of the welding operators employed to meet the requirements of Section IX, except as hereinafter provided.

(*a*) The analysis of the deposited weld metal shall be substantially the same as that of the material being joined except that when the fabricator is of the opinion that a physically better joint can be made by departure from these limitations and the user and inspector are satisfied that the properties will be satisfactory for the intended service these limitations may be waived. (See Appendix.)

(*b*) Welded test plates similar to those required for Par. U-68 vessels shall be made for each U-69 or U-201 vessel.

(*c*) In the welding procedure qualification for butt welds in material less than $^3/_{32}$ in. in thickness, all tests called for in Table Q-1 may be omitted except the two reduced-section transverse tensile test specimens and two free bend test specimens which shall be made of the thinnest material to be used in construction, and in accordance with Fig. Q-6 and Q-7. These specimens when tested in accordance with Par. Q-108 (**a**) and (**b**) shall meet the test requirements of Pars. Q-109 (**a**) and (**b**).

For qualification of a fillet welding procedure in such material, all tests called for in Par. Q-105 (**b**) may be omitted except the two transverse shear test specimens which shall be made of the thinnest material to be used in construction, and in accordance with Fig. Q-4. These specimens when tested in accordance with Par. Q-108 (**d**) shall meet the test requirements of Par. Q-109 (**d**).

(*d*) The operator qualification tests for welding material less than $^3/_{32}$ in. in thickness shall be the same as for $^3/_8$-in. thick material except that the thickness used for the test welds shall be the thinnest material to be used in construction. These specimens when tested in accordance with Par. Q-208 in a guided bend test jig modified as called for in (*c*) shall meet the test requirements of Par. Q-209. This test shall qualify the operator for welding a range of thickness from the test thickness to twice the test thickness, inclusive.

(*e*) If the thickness of the guided bend test specimen is other than $^3/_8$ in., the testing shall be done in a test jig similar to Fig. Q-19 with the plunger and die member proportioned as follows:

Thickness of plunger member—4 times the thickness of the test specimen.

Radius of plunger member—2 times the thickness of the test specimen.

Width of opening die member—6 times the thickness of the test specimen plus $^1/_8$ in.

Radius of die member—3 times the thickness of the test specimen plus $^1/_{16}$ in.

APPENDIX TO CASE No. 989

A(1)(*a*) It is expected that vessels of alloy steels covered by these rules will often be used to hold liquids and gases corrosive to ordinary materials, but the selection of an alloy suitable for the vessel's contents and the determination of corrosive allowances are not covered by these rules.

It is recommended that users assure themselves by appropriate tests, or otherwise, that the alloy selected and the treatment following fabrication are suitable for the service intended.

When service data are not available, the procedure of Par. U-11 (**b**) should be followed.

It is recommended that the use of austenitic stainless steel welds be avoided on vessels which are intended for services involving severe temperature conditions, particularly those of a cyclic nature, because of the dissimilar coefficients of expansion between weld and base materials.

CASE No. 1109

(*Special Ruling*)

Inquiry: Case No. 1087 permits the hydrostatic test pressure on fusion welded boiler parts to be 1.5 times the maximum allowable working pressure. For the sake of uniformity may unfired pressure vessels be tested at 1.5 times instead of 2 times as now specified by Section VIII of the Code?

Reply: It is the opinion of the Committee that in recognition of the improvements made in welded construction the hydrostatic test pressure to be applied to welded unfired pressure vessels shall be not less than 1.5 times the maximum allowable working pressure, except where lower test pressures are specifically permitted in the Code.

Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its Codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the Code. They are published herewith with corresponding paragraph numbers to identify their location in the various sections of the Code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the Code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

TABLE P-5. Delete reference to Specifications SA-53 grade A and grade B in the August 9, 1949, Power Boiler Addenda sheet and add as electric resistance welded carbon-steel pipe to Table P-5 of the Power Boiler Code.

PAR. P-3. Revise as follows:

Open-hearth, electric furnace OR DEOXIDIZED ACID BESSEMER steel pipe or steel tubing may be used for boiler pressure parts exposed to the fire or products of combustion.

PAR. P-9(**d**). Revise as follows:

For sizes over 3 in. in diameter, the steel pipe shall be of open-hearth, ELECTRIC FURNACE OR DEOXIDIZED ACID BESSEMER steel.

PAR. U-77(**a**). In line four change "twice" to "one and a half."

PAR. U-77(**b**). In line five on page 360 of Unfired Addenda, change "$1^1/_2$ times but not more than 2 times" to "$1^1/_4$ and not more than $1^1/_2$ times."

PAR. U-77(**b**). In line 20 change "twice" to "one and a half."

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

EJC Reports on 1950 Graduate Employment Opportunities

30 Per Cent Reduction Indicated

EMPLOYMENT horizons for engineers graduating in 1950 will be only 70 per cent as bright as it was in 1949, according to a survey of 1950 employment programs for graduates in engineering and the physical sciences recently completed by the General Survey Committee of the Engineers Joint Council and made public at the regular EJC meeting in the Engineering Societies Building, New York, N. Y., March 17, 1950.

The survey was based on returns from 144 industrial organizations, 23 state and federal agencies employing engineers, and 64 colleges. These organizations employ more than three million persons, of whom 66,400 are engineering graduates. What the EJC Committee was after was (1) useful information on the relative demand in 1949 and 1950 for inexperienced graduates from selected employers of engineers and physical-science graduates, and (2) starting salaries for graduates holding various degrees. This survey is the second completed by the Committee. The first was published in the August, 1949, issue of Mechanical Engineering, pages 665–668.

Survey Findings

Summary of the findings follows:

(1) Reporting organizations hired 8000 engineering graduates in 1949 but expect to hire 5550, or 30 per cent fewer, in 1950. For industrial companies the decrease is 28 per cent; for government agencies, 33 per cent; and for engineering colleges, 44 per cent.

(2) The same organizations hired 1500 graduates in the physical sciences in 1949 but expect to hire 1250 or 16 per cent less in 1950. For industrial companies the decrease is 18 per cent; for government agencies, 40 per cent; and for colleges, 55 per cent.

(3) The reporting organizations expect to hire 1530 mechanical engineers, 1410 electrical, 1350 civil, and 600 chemical engineers. Of the physical-science graduates, the organizations expect to hire 600 chemists, 415 physicists, and 170 trained in other related fields.

(4) By engineering curricula, the decreases in expected employment are all of the same general order of about 30 per cent, except that a decrease of only 5 per cent from 1949 is expected in chemical engineering. Among physical science graduates, the employment of chemists is expected to decrease by 14 per cent, but that of physicists to increase by 7 per cent. In both general fields, decreases are expected at the bachelor's and master's level, but an increase of 27 per cent at the doctor's level.

(5) With few exceptions, the reporting organizations use the same basic starting rates for all engineering and physical-science graduates at each degree level. Among the bachelors, 25 per cent will receive a rate of $275 per month or more, 50 per cent a rate of $255 a month or more (the so-called median), and 75 per cent one of $245 or more. The median for the industrial companies is also $255, but the corresponding figure for the government agencies and colleges is $260. For organizations seeking primarily chemical engineers the median is $280, for other organizations seeking mainly civil, electrical, or mechanical engineers, only small variations from the general $255 figure occur. Among industries, the highest medians are found in the chemical and petroleum companies, $300 and $290 per month, respectively.

(6) For technical graduates receiving master's degrees, the over-all median is $320 per month, and this figure is also found in the governmental agencies and engineering colleges. In industrial companies, it is $5 higher.

At the doctor's level, the over-all median of $445 is found also in industry and government, but in the engineering colleges the corresponding rate is $390. At this level there are no significant variations in the median rates of organizations seeking men from different curricula. At the master's level, however, those employing primarily chemical engineers use a median rate of $335; those employing primarily electricals, one of $295.

(7) For all the organizations reporting and for the industrial companies included, the median total increase by the end of the first year of employment is $25 per month, but for the engineering colleges this figure is $20 and for the governmental agencies $12. In all organizations, 65 per cent give this increase at one time, 33 per cent in two installments, and only 2 per cent in three bites. In only one third of all organizations, but two thirds of the governmental agencies, is it on an automatic rather than merit basis.

(8) Only about one quarter of the total number of industrial and governmental organizations with 1950 quotas for engineering graduates report starting rates for graduates in business administration and even fewer a rate for those in arts. At the bachelor's level, a median rate of $250 is found for both curricula (as compared with $255 for technical graduates) and at the master's level, the medians are $275 and $270, respectively (against $320).

Interpretation of Findings

With respect to starting salaries, the EJC Committee considers it significant that, for those with the bachelor degree, little change was evident from conditions in 1949. At the master's and doctor's level, however, the Committee interpreted the increased medians as an indication of higher evaluation being placed by industries on advanced training. Salary increases during the first year tend to be somewhat smaller, to be given at one time, and later in the period.

A marked decline in the number of organizations reporting on business and arts graduates suggests that employment of such graduates probably will drop more sharply than that of technical graduates.

Extrapolation of the demand reported in the 1949 Survey indicated a total employment of some 25,000 new graduates, but when the Committee checked actual placements late in 1949, it was learned that some 37,000 graduates had been hired and that the total placement was estimated to be still greater.

The major part of this difference, the Committee felt, was due to the opportunities for employment with a large number of relatively small organizations not covered in the Survey. Many of the smaller companies who were not able to secure engineering graduates in the intense competition shortly after the war, found that they were able to hire 1949 graduates.

Opportunities With Small Companies

With the larger graduating class this year and the substantial decrease in the demand from organizations participating in this survey, intensive cultivation of the smaller organizations for openings not only in engineering but in production and operations, leading to supervision and sales, offers the best chance for satisfactory placement results. In view of the situation, moreover, employing organizations with either immediate or long-term needs for men with technical training have an exceptional chance to fill such needs with carefully selected men. About 51,000 bachelor's degrees will be given in engineering during the current year.

Next year the total will be 30 per cent less, and on the basis of freshman and sophomore enrollments there will be further sharp declines in 1952 and 1953.

Copies of the full report including 14 tables can be obtained by writing to the Secretary, Engineers Joint Council, 29 West 39th Street, New York, N. Y.

PORTRAIT OF JOSEPH BRAMAH, EIGHTEENTH-CENTURY INVENTOR AND HYDRAULIC ENGINEER, RECENTLY UNVEILED IN THE COUNCIL ROOM OF THE INSTITUTION OF MECHANICAL ENGINEERS LONDON, ENGLAND

(Joseph Bramah, son of a farmer, was born in 1749 and died in 1814 as the mechanical genius of his time. His first patent for an improved water closet was granted when he was 29. Then followed a variety of mechanical and hydraulic inventions which gave an impetus to science and the industrial revolution. Among his inventions are a water cock, a fire engine, a hydraulic press, a safety lock still being manufactured under his name, a numerical printing machine for bank notes, and others. He was the first to suggest the practicability of screw propellers and hydraulic transmission.

The portrait was purchased from Val Wood, a great-great-grandson of Joseph Bramah, and presented to the Institution as part of the bicentennial celebrations of the inventor's birth.)

EJC Granted Special Status by United Nations

ENGINEERS Joint Council was recognized by the Economic and Social Council of the United Nations recently as an important agency in International affairs and was placed on the newly established register of organizations capable of giving assistance to the United Nations. Under this status EJC will receive U N agenda; will have the right to have an observer at all U N meetings, and may contract with the United Nations to carry out special studies or investigations.

This development was reported by E. A. Pratt, EJC liaison representative with the United Nations, at a meeting of the EJC in the Engineering Societies Building, New York, N. Y., March 17, 1950.

In connection with the proposed UPADI (Union of Pan-American Engineering Societies) Congress in Havana, Cuba, in late 1950, EJC is planning to establish a Latin-American Commission to make plans for United States participation. The matter of co-ordinating work of the American Society for Engineering Education and the EJC in international relations is under consideration. EJC is also undertaking a study aiming at co-ordination of policy for EJC societies with respect to membership outside the United States.

General Survey Committee

Donald S. Bridgman, secretary of the EJC Survey Committee, reported that the Committee's 1950 survey of employment opportunities for graduating engineers indicated that American industry was planning to hire 30 per cent less graduating engineers than in 1949. Mr. Bridgman's report is covered more fully on page 433.

Favorable response to an EJC proposal that an Advisory Committee of Engineers be created to confer with the U. S. Civil Service Commission in connection with practices and policies relating to placement and retention of engineers in federal service, was reported by J. H Ehlers for the EJC Committee on Engineers in U. S. Civil Service. This development is considered important by EJC because during the last few years, the professional status of engineers employed in the federal government has not always been respected.

Science Legislation

With the imminent passage of the National Science Foundation Bill now in conference before the Senate and the House of Representatives, B. A. Bakhmeteff recommended and the Council voted (1) to name R. E. Dougherty as EJC delegate to go to the White House for the purpose of urging that a reasonable number of engineers be among the men to be appointed to the National Science Foundation governing board and (2) that the secretaries of EJC constituent societies each appoint one man to work with Mr. Bakhmeteff in reviewing the list of candidates recommended to President Truman in 1948.

The Council heard a progress report from W. W. Horner, chairman of its Committee on Water Policy. Mr. Horner said that his Committee was planning to present its report during the summer to the Water Resources Commission appointed by President Truman.

242 Manufacturers Engage Space for Power Show

MANUFACTURERS serving the mechanical-engineering and power industries are acting early to engage space for the 19th National Exposition of Power and Mechanical Engineering to be held in Grand Central Palace, New York, N. Y., Nov. 27-Dec. 2, 1950. Among the 242 leading manufacturers who have already engaged space, many have been represented at the annual Power Show since its inception in 1922.

The exposition has always been an important event in the power industry, but this year an even greater interest is forecast due to the active co-operation of The American Society of Mechanical Engineers whose Annual Meeting will be held in New York during the same week.

Announcement of the exposition to companies that were not represented in the last exposition has recently been mailed and reports from the management indicate exceptional interest. Some desirable space locations are still available, and all inquiries should be addressed to the exposition at Grand Central Palace, New York 17, N. Y. Charles F. Roth is manager; E. K. Stevens, associate manager.

Co-Ordination of Engineering-Student Activities Recommended

THAT national engineering societies having student branches should be diligent about implanting ideas of unification and co-ordination of the engineering profession on engineering-school campuses was the consensus of 13 representatives of nine national engineering societies who met on Jan. 27, 1950, in the Engineering Societies Building, New York, N. Y., as the Inter-Society Conference on Student Branches. The Conference, sponsored by the American Society of Civil Engineers, first met on Sept. 13, 1949, to consider what could be done about the growing confusion on American engineering-school campuses caused by too many student branches, each competing for the loyalty of the student.

Recommendations

As a result of the exploratory session held last September, representatives came to the second session prepared to agree generally on what engineering societies could do to improve the situation. It was the consensus that the societies should prepare a set of principles regarding operation of engineering student branches for the guidance of college administrators. The representatives also felt that most campuses had reached the saturation point with regard to additional student branches and that if a new student activity became desirable in the future, an attempt should be made to incorporate that activity within existing student branches rather than to encourage a new student branch.

The group looked with favor on the trend to student-branch councils as a method of co-ordinating student-branch activities.

The representatives recommended that the engineering societies should take the initiative in formulating a program of activities which would contribute to the professional consciousness of engineering students. The Conference recognized that engineering societies should utilize student organizations as the seedbed of the engineering profession to promote unity of the profession.

The Conference recommended that national engineering societies demonstrate professional unity by accepting for a junior membership, any student member of an approved student-engineering group without requiring payment of an additional admission fee.

To give the Conference as broad a sponsorship as possible, the group formally voted

that its recommendations be presented to the Engineers Joint Council with the request that the work be taken over by a new group organized as part of the EJC Committee on Unity of the Engineering Profession.

Organizations Co-Operating

The following organizations were represented at the Conference: American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Chemical Engineers, American Society for Engineering Education, Society of Automotive Engineers, National Society of Professional Engineers, American Road Builders' Association.

Eugene W. O'Brien, Paul B. Eaton, and Ernest Hartford represented the ASME at the Conference.

Closing Date for EJC Survey Advanced to July 15

CLOSING date of the Selected Engineering Personnel Survey sponsored by the Engineers Joint Council for the Office of Naval Research has been advanced to July 15, 1950, because only two out of every three engineers who received the questionnaire have returned it.

The objective of the current survey is a file of key engineers working in research, development, and other scientific projects who can be called upon in time of national emergency to work full or part time on broad scientific programs for the United States Department of Defense. The availability of such a file will insure full utilization of American engineers in tasks for which they have been trained.

The questionnaire was mailed last June to nearly 100,000 engineers holding the full professional grade of membership in 18 national engineering societies. Two thirds of the questionnaires have been returned and tabulated but some 31,000 are still hiding away on desks and in files of engineers who have a great deal to contribute to the national defense program.

Since the omission of such a large segment of the engineering profession from the proposed file will seriously limit its usefulness, the Office of Naval Research has authorized the mailing of a third reminder to tardy engineers.

Engineers who receive the reminder are urged to return the questionnaire so that their professional training and experience can be available. Even though an engineer may not now be engaged in research or development work, his services may be important to the country by virtue of his special training and professional recognition granted him by his professional society. The survey is sponsored by the EJC under a contract by The American Society of Mechanical Engineers and the Office of Naval Research acting for the National Military Establishment which is now called the U. S. Department of Defense.

EJC Invites Recommendations on National Water Policy

Prompt Action Urged to Meet June 1 Deadline

AID of American engineers is being sought by the National Water Policy Panel of the Engineers Joint Council in developing an emergency report expressing engineering opinion and recommendations on national water policy for submission to President Truman's "Temporary Water Resources Commission" by June 1, 1950.

As the co-ordinating agency of five national engineering societies, EJC was asked by the President's Commission to report recommendations of the engineering profession for consideration and guidance of the Commission.

More than 100 prominent engineers have been organized into eight task committees by the EJC Panel's special co-ordinating committee headed by Abel Wolman of The Johns Hopkins University, as chairman, and W. W. Horner, consulting engineer, St. Louis, Mo., as general chairman.

The immediate objective of the Committee is to formulate a statement of professional opinion pertaining to water policy and practice in conservation, utilization and protection of water resources with special emphasis on immediate and long-range development of public water supply for domestic and industrial, agricultural and recreation uses.

Because of the importance of the EJC report, the task-committee chairmen meeting with members of the Panel and Co-Ordinating Committee, invited members of the engineering profession, especially domestic and industrial water-supply officials and stream-control authorities, to submit recommendations which the task committees might consider for incorporation in the emergency report.

Because the time is short, engineers are urged to mail promptly constructive suggestions and recommendations directly to the chairman responsible for that phase of the water-policy report to which the recommendations pertain. A list of EJC task committees and chairmen follows:

1 *Domestic and Industrial Water Supply Pollution*, chairman, L. R. Howson, Alvord, Burdick, and Howson, 20 North Wacker Drive, Chicago, Ill.

2 *Flood Control and Water Flow Retardation*, chairman, J. A. Short, Missouri Department of Resources and Development, State Office Building, Jefferson City, Mo.

3 *Navigation and Water Transportation*, chairman, Col. Cary H. Brown, Eastman Kodak Company, Rochester, N. Y.

4 *Irrigation*, chairman, S. T. Harding, University of California, 12 Engineers Building, Berkeley, Calif.

5 *Hydroelectric Power*, chairman, Col. F. W. Sheidenhelm, consulting engineer, 50 Church Street, Suite 1380, New York 7, N. Y.

6 *Recreation, Fish and Wild Life Aspect of Water Resources*, chairman, M. P. O'Brien, University of California, Berkeley, Calif.

7 *Basic Water Resources Information*, chairman, G. R. Williams, Knappen, Tippetts, Abbott Engineering Company, 62 West 47th Street, New York, N. Y.

8 *Land Drainage*, chairman, Edmund Friedman, consulting engineer, M. H. Connell and Associates, 200 Langford Building, Miami, Fla.

Fourth World Power Conference to Meet in London in July

THE United States delegation to the Fourth World Power Conference, to be held in London, July 10–15, 1950, will contribute 21 papers, 13 of which will be by members of The American Society of Mechanical Engineers. The Conference, whose theme is "World Energy, Resources, and the Production of Power," will have its technical sessions arranged under three divisions: Energy resources of power developments; preparation of fuels; and production of power.

Thirteen Fellows and members have been designated as honorary vice-presidents to represent The American Society of Mechanical Engineers at the Conference. They are: C. B. Campbell, A. G. Christie, C. W. E. Clarke, F. P. Fairchild, W. C. Schroeder, George A. Stetson, Paul W. Thompson, P. H. Chase, Alf Kolflat, W. W. Kuyper, B. A. Landry, E. E. Parker, and W. H. Rowand.

Countries Participating

Engineers from the following countries will participate in one or more of the divisions of the technical program: Algeria, Argentine Republic, Australia, Austria, Belgium, Canada, Chile, Czechoslovakia, Denmark, Egypt, Finland, France, Great Britain, Greece, Hungary, India, Ireland, Italy, Netherlands, Norway, Pakistan, Poland, Portugal, Union of South Africa, Sweden, Switzerland, Yugoslavia, and the United States of America.

Papers to be presented by engineers from the United States follow:

Division I

Energy Resources of the United States, by W. E. Wrather, director, Geological Survey, Washington, D. C.; James Boyd, director, Bureau of Mines, Washington, D. C.; Nelson Lee Smith, chairman, Federal Power Commission, Washington, D. C.; and Eugene Ayres, director of research, Gulf Research and Development Company, Pittsburgh, Pa.

Division II

Trends in Mechanical Mining and Preparation of Coal for Steam Generation, by J. B.

Morrow, president, and Henry F. Hebley, division of research, Pittsburgh Consolidated Coal Company, Pittsburgh, Pa.

Advances in Petroleum Refining, by W. M. Holaday, director, Socony-Vacuum Laboratories, Socony-Vacuum Oil Company, Inc., New York, N. Y.

Synthetic Liquid Fuels, by W. C. Schroeder, chief, Office of Synthetic Liquid Fuels, Bureau of Mines, Washington, D. C.; and A. C. Fieldner, chief, Fuels and Explosives Division, Bureau of Mines, Washington, D. C.

Transportation, Storage, and Peak-Load Supply of Natural Gas, by George H. Smith, assistant managing director, American Gas Association.

Manufacture of Fuel and Synthesis Gas in the United States, by L. L. Newman, gas engineer, Coal Branch, Bureau of Mines, Washington, D. C.; L. D. Schmidt, chief, Synthesis Gas Production Branch, Bureau of Mines Morgantown, W. Va.; and H. R. Batchelder, chemical engineer, Bureau of Mines, Louisiana, Mo.

Meetings of Other Societies

May 21–26

American Water Works Association, annual conference, Convention Hall, Philadelphia, Pa.

May 23–26

National District Heating Association, 41st annual meeting, Grove Park Inn, Asheville, N. C.

May 25–26

The Society of Naval Architects and Marine Engineers, spring meeting, Hotel Cleveland, Cleveland, Ohio

May 25–27

Society for Experimental Stress Analysis, spring meeting, Hotel Statler, Cleveland, Ohio

June 4–7

American Society of Refrigerating Engineers, 37th spring meeting, Muehlebach Hotel, Kansas City, Mo.

June 18–21

American Society of Heating and Ventilating Engineers, semi-annual meeting, Royal Muskoka Hotel, Muskoka Lakes district, North of Toronto, Ont., Can.

June 19–23

American Society for Engineering Education, annual meeting, Seattle, Wash.

June 26–30

American Society for Testing Materials, 53rd annual meeting, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

(*For ASME Calendar of Coming Events see page 444*)

Division III

Design of Modern Steam Generating Units for High-Pressure, High-Temperature Service, by Wilbur H. Armacost, vice-president, Combustion Engineering-Superheater, Inc.

Trends in American Boiler Performance Requirements, by W. H. Rowand, chief engineer, Babcock & Wilcox Company, New York, N. Y.

Trends and Development in Steam Turbine Practice for Central Station Service, by C. B. Campbell, manager of engineering, Steam Division, Westinghouse Electric Corporation.

Progress in Design of Steam Turbines for Electric Power Generation in the United States, by Edwin E. Parker, manager of engineering, Turbine Division, General Electric Company, Schenectady, New York.

Mercury-Cycle Power Generation—A Progress Report, by Harold N. Hackett, Construction Engineering Division, General Electric Company.

Operating Experience With High-Pressure, High-Temperature Steam Central Stations, by P. W. Thompson, vice-president in charge of engineering, The Detroit Edison Company, and chairman of the Committee on Power Generation of the Association of Edison Illuminating Companies.

Summary of Current Developments in Large Diesel and Gas Engines, by R. L. Boyer, vice-president and chief engineer, The Cooper-Bessemer Corporation, Mount Vernon, Ohio.

Summary of Current Developments in Small Diesel Engines, by M. R. Bennett, assistant chief engineer, industrial power engineering department, International Harvester Company.

American Gas-Turbine Practice, by L. N. Rowley, executive editor, and B. G. A. Skrotski, associate editor, *Power*.

Aircraft Gas Turbines, by J. S. Alford, General Electric Company.

State of Hydroelectric Power Development in the United States, by E. Robert de Luccia, chief, Bureau of Power and Frank L. Weaver, chief, Division of River Basins, U. S. Federal Power Commission.

Hydroelectric Power—Available Power and Delivery of Water to the Powerhouse, by William F. Uhl, president, and Byron O. McCoy, engineer, Charles T. Main, Inc.; and William P. Creager, consulting engineer.

Hydroelectric Power—Design and Operation of Powerhouse and Equipment, by E. B. Strowger, hydraulic engineer, Buffalo Niagara Electric Corporation.

Heat-Pump Progress in the United States, by Philip Sporn, president, and others of the American Gas and Electric Service Corporation.

Nuclear Energy for Power Production—Part II, by Ward F. Davidson, research engineer, Consolidated Edison Company of New York, Inc.

Notes on Coming Meetings

Plastics

THE mechanical properties of plastics as viewed from the standpoint of research and engineering application will be the subject of a three-day conference at the Massachusetts Institute of Technology, Cambridge, Mass., June 19–21, 1950. The conference is being sponsored by the M. I. T. Plastics Committee of which A. G. H. Dietz, Mem. ASME, is chairman. The program consists of 21 papers on such subjects as "Dynamic Properties of Rubberlike Materials," "Complex Stressing of Polymers," "Engineering Adhesives," and others. For further information, write to Professor Dietz, Room 5-209, MIT, Cambridge 39, Mass.

Mathematics

An International Congress of Mathematics will be held at Harvard University, Cambridge, Mass., Aug. 30–Sept. 6, 1950. G. H. McCullough, Worcester Polytechnic Institute, Worcester, Mass., and H. Poritsky, General Electric Company, Schenectady, N. Y., will represent The American Society of Mechanical Engineers.

Trade Fair

The First United States International Trade Fair to be held in Chicago, Ill., Aug. 7–19, 1950, will give industrial countries of Europe a chance to show their products to the American public. Many countries have already contracted for space either at the Navy Pier, International Amphitheater Coliseum, or the Arena, where the Fair will be held.

Petroleum

What is new in petroleum technology will be reviewed at the Third World Petroleum Congress to be held at The Hague, Netherlands, May 21–June 6, 1951. The organizing committee is working up a program in which many countries including the United States will participate.

Heat Transfer

The 1950 Heat Transfer and Fluid Mechanics Institute meeting, sponsored by the California engineering colleges in co-operation with California sections of national engineering societies, will be held at the Institute of the Aeronautical Sciences, 7660 Beverly Boulevard, Los Angeles, Calif., June 28–30, 1950.

Education

APPRECIATION by industry of the need to keep engineering schools abreast of modern developments and trends was reflected recently in the decision of the Doehler-Jarvis Corporation, New York, N. Y., to donate fully-equipped die-casting machines to the following schools: Massachusetts Institute of Technology, Rensselaer Polytechnic Institute, Case Institute of Technology, and Illinois Institute of Technology.

In addition to the machines, the company will make available to the schools as they need it, the services of their experts who will give lectures and demonstrate operation of the machines.

A SPECIAL professional-engineering program in Applied Mechanics will be offered by the Virginia Polytechnic Institute, Blacksburg, Va., June 14-July 22, 1950. Two features of the program will be a course by Sir Richard V. Southwell on Relaxation Methods, and a Symposium on Modern Developments in Design in which five eminent engineers will participate.

The program will not be of a review nature but will present essentials of new developments "packaged for practicing and research engineers, professors of the engineering sciences, and graduate students."

Symposium lecturers will be Hardy Cross, Yale University; M. Hetenyi, Northwestern Technological Institute; Lydik S. Jacobsen, Stanford University; Raymond D. Mindlin, Columbia University; and D. B. Steinman, consulting engineer.

For further information write to D. H. Pletta, Department of Applied Mechanics, Virginia Polytechnic Institute, Blacksburg, Va.

Engineering Literature

Nuclear Glossary

A GLOSSARY of nuclear terms used in biophysics and radiobiology has been published by The American Society of Mechanical Engineers. The glossary is Section VI of a larger glossary which will cover in nine sections, all terms used in nuclear science and technology. Other sections now in preparation will carry definitions of nuclear terms under the following headings: (1) General Terms, (2) Reactor Theory, (3) Reactor Engineering, (4) Chemistry, (5) Chemical Engineering, (7) Instrumentation, (8) Isotopes Separation, (9) Metallurgy.

Section VI was issued as a preliminary edition in order to make the information available for general distribution and to give users an opportunity to participate in revision. Each section will be divided into two parts; the first containing definitions of terms pertaining to it, and the second, an alphabetical index of terms contained in all sections.

The glossary was prepared under the sponsorship of the National Research Council which called a conference in the summer of 1948 of 21 societies and organizations interested in preparing a glossary of nuclear terms.

Copies of Section VI may be obtained from the Order Department, ASME, 29 West 39th Street, New York 18, N. Y. Price is 60 cents.

Elevator Safety Code

S. W. JONES, chairman of the Sectional Committee concerned with the preparation of the American Standard Safety Code for Elevators, Escalators, and Dumbwaiters, announced that a proposed revision of the section covering Private Resident Elevators has been released in draft form. Copies may be obtained from Standards Department, The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

People

ASME Elects Four Fellows

THE American Society of Mechanical Engineers has honored four of its members by electing them to the grade of Fellow of the Society.

To be qualified as a nominee to the grade of Fellow one must be an engineer who has acknowledged engineering attainment, 25 years of active practice in the profession of engineering or in a school of accepted standing, and has been a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council, to be approved by Council.

The men who, by virtue of their contributions to their profession and to the Society, were so honored are:

Sydney Dillon

Sydney Dillon, chief engineer until his retirement, Carnegie-Illinois Steel Corporation, Pittsburgh, Pa., was born in Altoona, Pa., June 21, 1877. He received his education in the public schools and attended private evening classes in Braddock, Pa., for six years. Under Mr. Dillon's direction were built the open-hearth plant and rail mills at the Edgar Thomson Works, the Clairton By-Product Coke Works, largest in the world, Carnegie-Steel River Transportation System, Marine Ways River Terminals, and Irving Works. In 1935 he had the problem of combining the engineering and construction work of Carnegie Steel, Illinois Steel, Lorain Steel, and American Sheet and Tin Plate, when Carnegie-Illinois Steel Corporation was formed. Mr. Dillon contributed to the advancement of the science of engineering chiefly through his outstanding vision and foresight in the selection of new and better equipment and processes for steelmaking.

Ralph Emmons Hall

Ralph E. Hall, director, Hall Laboratories, Inc., Pittsburgh, Pa., was born in Charlestown, Ohio, Feb. 28, 1885. He received a PhD degree in chemistry, University of Chicago, 1916. Dr. Hall is recognized internationally as a pioneer in the field of scientific conditioning of boiler water. Through his work in this field he has received the Pittsburgh Award, American Chemical Society Pittsburgh Section, 1933; the degree of doctor of science, Ohio Wesleyan University, 1936; the professional degree of chemical engineer, Ohio State University, 1939; and Award of Modern Pioneer of the National Association of Manufacturers, 1940. Although published 22 years ago and long out of print, his book, "Physico-Chemical Study of Scale Formation and Boiler-Water Conditioning," remains a standard reference work.

He is the author of many technical papers on the subject and is inventor or coinventor of more than 50 United States and foreign patents.

Isaac Harter

Isaac Harter, chairman of the board, The Babcock & Wilcox Tube Company, Beaver Falls, Pa., was born in Mansfield, Ohio, Jan. 2, 1880. He was educated at the University of Pennsylvania and in 1901 received a BS degree. Since 1909 he has been allied with the Babcock & Wilcox Company. While investigating cracking of boiler drums in service, he conducted experiments to prove that such failures were due to action of caustic soda. This resulted in a change in feedwater treatment for all naval vessels. During this period Mr. Harter was actively associated with the small group who promoted the formation of the ASME Boiler Code and was mainly instrumental in securing early legislation in Ohio resulting in the Ohio Boiler Code. He was concerned with the formation of the American Uniform Boiler Law Society to secure uniform state laws based on the ASME Code. He has been associated in work for the Atomic Energy Commission, first, as a member of the Industrial Advisory Committee, and now as one of the Commission's Patent Compensation Board. A number of patents have been issued to Mr. Harter individually and jointly with others in fields of boiler design, industrial furnaces, refractories, continuous casting, and steelmaking machinery.

Marcello Aberdeen King

Marcello A. King, vice-president in charge of engineering, Elliott Company, Jeannette, Pa., was born in Wellsville, N. Y., Dec. 1, 1892. He studied at the University of Michigan and received a BSME degree in 1916. He has developed commercial lines of turbines in ranges of pressure, temperature, and capacity which had not been encountered previously except in special machines. His part in these developments was to supply technical direction and co-ordination. These turbines have been successful in a true engineering sense because they have given excellent service at low cost. One particular turbine development, that of turbines for driving dredge pumps, is particularly noteworthy. His contribution to the development of hydraulic dredging was itself an important achievement in American engineering.

PAUL SCHWARZKOPF, president, American Electro Metal Corporation, Yonkers, N. Y., received the 1950 Powder Metallurgy Medal of the Stevens Institute of Technology, Hoboken, N. J., March 29, 1950. The Medal is conferred annually for outstanding achievement in the field of powder metallurgy.

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JOSEPH M. CLARK, editor for 30 years of the ASME Catalog and Directory, has assumed full charge of this publication. In his new capacity as manager of the ASME Catalog and Directory, Mr. Clark will handle sale of space and will be responsible for editing.

ASME NEWS

Many Attractions Planned for ASME 1950 Semi-Annual Meeting

Headquarters: Hotel Statler, St. Louis, Mo.
Date: June 19–23

AN air-conditioned headquarters hotel, a technical program of unusual interest, an opportunity to visit some of the nation's finest industrial plants, and the pleasure of meeting old friends, will be some of the attractions of the 1950 Semi-Annual Meeting of The American Society of Mechanical Engineers to be held at the Hotel Statler, St. Louis, Mo., June 19–23, 1950.

St. Louis, "The Gateway to the West," is ideally situated for the Society's second largest national meeting because it brings to midwestern members of the Society, a meeting which rivals the Annual Meeting in scope and importance. The Semi-Annual Meeting is the background for the nomination of new officers and for the Regional Delegates Conference. The Regional Delegates Conference, composed of two representatives of each of ASME Regions, discuss an agenda which touches on all phases of Society administration. At this Conference suggestions for improving Society services to members are discussed from a national point of view and those which have merit are passed on to the Council.

Technical Program

A feature of the technical program will be two technical sessions and a luncheon at which the Institute of Aeronautical Sciences and the American Helicopter Society will join the ASME Aviation Division in a discussion of helicopter flight testing, helicopter pressure jets, rotor systems, and flight research data. For other papers to be presented at more than 30 technical sessions, see the tentative program which appears on the following pages.

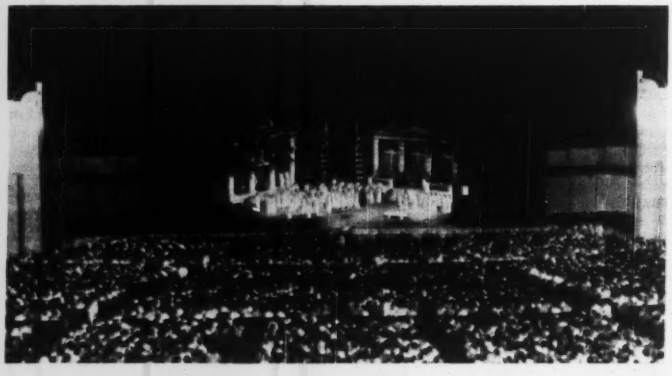
President Cunningham to Speak

The social part of the program will consist of three luncheons and a banquet, commencing with the welcome luncheon on Monday at which James D. Cunningham, president ASME, will welcome members and guests. At the banquet on Wednesday, it is planned to present the 1950 Spirit of St. Louis Medal and the Spirit of St. Louis Junior Award. The medal is awarded at approximately three-year periods to persons who have contributed to the advancement of aeronautics. The Junior Award, also made every three years, consists of a cash award of $50 and a certificate which is given to a junior member of the Society under 30 years of age for the best paper on an aeronautical subject. At the Thursday luncheon, the American Ordnance Association will join the Society to hear Col. James L. Walsh, president of the American Ordnance Association, who will speak on the subject "Working for Peace."

As a service to members who want to hear luncheon speakers but do not want to attend the luncheons, the St. Louis Section is planning to post exact times of luncheon addresses and to provide additional seats up to the capacity of the rooms so that when the luncheons have been served, members will be able to participate in the programs in comfort.

Inspection Trips

Seven interesting trips to representative industries in the St. Louis area have been arranged for members. They will start on Tuesday, June 20, with a tour of the Midwest Piping and Supply Company, Inc., where members will have a chance to see fabrication of pressure and process piping and the manufacture of welding fittings. At the same time another group will leave for the Wagner Electric Corporation to inspect a modern plant manufacturing small motors, transformers, automotive, electrical, and hydraulic brake equipment. In the afternoon another party will leave for the Western Cartridge Company, East Alton, Ill., where they will see the manufacture of cartridge ammunition, and brass sheets and strips, in one of the largest brass mills under one roof. On Wednesday morning a trip has been arranged to the Venice Power Plant of the Union Electric Company. A popular trip will be the one to Anheuser-Busch Brewery where the points of interest will be the large high-pressure steam power plant with its newly installed equipment. On Thursday afternoon the McDonnell Aircraft Corporation will play host to an ASME party which will inspect aircraft-manufacturing operations. For Friday a trip of special interest for members of the Power and Fuel Division has been planned. This will take a party to the Synthetic Liquid Fuel Plant of the U. S. Bureau of Mines at Louisiana, Mo. Visitors will see equipment operating at 10,000 psi and temperatures up to 1000 F. This coal-hydrogenation plant has a scheduled output of from 200 to 300 barrels of gasoline per day.



THE MUNICIPAL OPERA THEATER IN FOREST PARK, ST. LOUIS, MO., ONE OF THE ATTRACTIONS TO BE ENJOYED BY THOSE WHO ATTEND THE ASME SEMI-ANNUAL MEETING, ST. LOUIS, MO.

The Tentative Program

SUNDAY, JUNE 18

8:00 a.m.

Registration

MONDAY, JUNE 19

9:30 a.m.

Power (I)—Fuels (I)

Electrostatic Collection of Fly Ash, by H. J. White, director of research; L. M. Roberts, manager, development research; and C. W. Hedberg, director of engineering, Research Corporation, Bound Brook, N. J.

Mechanical Dust Collectors, The Problem and Application, by John T. Doyle, vice-president, The Thermix Corporation, Greenwich, Conn.

Heat Transfer

12:00 noon

Welcoming Luncheon

Presiding: C. B. Briscoe, St. Louis, Mo.

Speaker: James D. Cunningham, president ASME, Chicago, Ill.
Subject: The Engineers' Civic Responsibility

2:30 p.m.

Gas Turbine Power (I)—Fuels (II)—Power (II)

Tests on Small-Scale Gas Producer, by B. O. Buckland, engineer, General Electric Company, Schenectady, N. Y.

A Progress Report on Gas-Turbine Combustors for Pulverized Coal, by Herbert R. Hazard, assistant supervisor, Battelle Memorial Institute, Columbus, Ohio.

Gas-Turbine Combustors for Gaseous Fuels, by A. E. Hershey, engineer, thermodynamics section, Westinghouse Electric Corporation, East Pittsburgh, Pa.

6:00 p.m.

Buffet Supper

8:00 p.m.

Junior Committee

Junior Conference: How Is Your P. D. (professional development)?
Speakers: I. T. Monseth, engineering and service manager, Westinghouse Electric Corporation, St. Louis, Mo., and C. M. Stanley, partner, Stanley Engineering Company, Muscatine, Iowa, also members of junior panel.

8:00 p.m.

Management

Fundamentals of Quality Control, by Arthur Bender, Jr., Delco-Remy Division, General Motors Corporation, Anderson, Ind.

The Return on Investment, by H. J. Lang, Day and Zimmermann, Inc., Philadelphia, Pa.

TUESDAY, JUNE 20

9:00 a.m.

Inspection Trip

Midwest Piping and Supply Company
Wagner Electric Corporation

9:30 a.m.

Aviation (I)—Institute of the Aeronautical Sciences (I)—and American Helicopter Society (I)

Flight-Testing Helicopters for Dynamic Stability, by John O'Dea, flight research engineer, Cornell Aeronautical Laboratories, Inc., Buffalo, N. Y.

The Helicopter Pressure Jet, by Friedrich L. V. Doblhoff, Helicopter Division, McDonnell Aircraft Corporation, St. Louis, Mo.

Hovering and Low-Speed Performance and Control Characteristics of an Aerodynamic Servocontrolled Helicopter Rotor System as Determined on the Langley Helicopter Tower, by Paul J. Carpenter, aeronautical research scientist, Langley Aeronautical Laboratory, The National Advisory Committee for Aeronautics, Langley Air Force Base, Va.

9:30 a.m.

Railroad (I)

Treating Feedwater for Railway Diesel Steam Generators, by John F. Wilkes, technical director, railroad department, Dearborn Chemical Company, Chicago, Ill.

Dynamics of "Shimmy" in Passenger-Car Trucks, by S. G. Guins, project engineer, Office of Research Consultant, Chesapeake and Ohio Railway Company, Cleveland, Ohio

THE AIR-CONDITIONED HOTEL STATLER, ST. LOUIS, MO., WHERE THE ASME WILL HOLD ITS 1950 SEMI-ANNUAL MEETING, JUNE 19–23

9:30 a.m.

Gas Turbine Power (II)—Power (III)

Safety Margins and Stress Levels in High-Temperature Equipment, by E. L. Robinson, structural engineer, turbine-engineering division, General Electric Company, Schenectady, N. Y.

Engineering and Construction Problems Involved in the Huey Gas-Turbine Installation, by C. C. Willis, superintendent of generation, Oklahoma Gas and Electric Company, Oklahoma City, Okla., and E. C. Goldsworth, field engineer, General Electric Company, New York, N. Y.

12:00 noon

Aviation—IAS—AHS Luncheon

Presiding:
Speaker: Frank N. Piasecki, president, Piasecki Helicopter Corporation, Morton, Pa.
Subject: To be announced.

12:00 noon

Management Division Luncheon

Speaker: Hugo Weissbrodt, general manager, Fort Wayne Motor Truck Division, International Harvester Company, Fort Wayne, Ind.
Subject: To be announced.

1:30 p.m.

Inspection Trip

Western Cartridge Company

2:30 p.m.

Applied Mechanics (I)

The Design of Resonant Quartz-Crystal Ultrasonic Transducers for Research Purposes, by G. W. Swenson, Jr., instructor in electrical engineering, and W. T. Thomson, associate professor of mechanics, University of Wisconsin, Madison, Wis. (50—SA-12)

The Solution of Elastic Plate Problems by Electrical Analogies, by R. H. MacNeal, Analysis Laboratory, California Institute of Technology, Pasadena, Calif.

Soap Film and Sandbed Mapper Techniques, by A. D. Moore, professor of electrical engineering, University of Michigan, Ann Arbor, Mich. (50—SA-15)

2:30 p.m.

Aviation (II)—Institute of the Aeronautical Sciences (II) and American Helicopter Society (II)

Practical Flight Research as Performed by the Air Materiel Command, by Maj. Vernon Prentiss, chief, and Nathan R. Rosengarten, civilian chief, flight research section, Flight Test Division, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio.

The NACA Balsa-Dust Method of Air-Flow Visualization and Its Application to Model Helicopter Rotors in Static Thrust, by Marion K. Taylor, aeronautical research scientist, Langley Aeronautical Laboratory of the National Advisory Committee for Aeronautics, Langley Air Force Base, Va.

An Analysis of Helicopter Propulsion System, by J. A. Johnson, chief engineer, Thermal Research and Engineering Corporation, Waltham, Mass.

2:30 p.m.

Railroad (II)

Development and Testing of Brakes for High-Speed Railroad Equipment, by Carl E. Tack, assistant chief mechanical engineer, American Steel Foundries, Chicago, Ill.

High-Speed Braking, by C. L. Eksergian, executive engineer and assistant to vice-president, The Budd Company, Philadelphia, Pa.

2:30 p.m.

Power (IV)—Fuels (III)

Knox Lee Power Plant's Pressurized Boiler—A New Trend in Steam Generation, by J. R. Welsh, vice-president, Southwestern Gas

Official Notice

ASME Business Meeting

THE Semi-Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday, June 19, 1950, at 5:00 p.m. in the Missouri Room of the Hotel Statler, St. Louis, Mo., as part of the Semi-Annual Meeting of the Society.

and Light Company, Shreveport, La., and L. Skog, Jr., mechanical engineer, Sargent and Lundy, Chicago, Ill.

A Cyclone-Fired Pressurized Steam Generator, by Merle Newkirk, manager, power division, The Dow Chemical Company, Midland, Mich.

8:00 p.m.

Applied Mechanics (II)

Fluid-Mapper Program, by A. D. Moore, professor of electrical engineering, University of Michigan, Ann Arbor, Mich. (A demonstration of a fluid-mechanics research apparatus

WEDNESDAY, JUNE 21

9:00 a.m.

Inspection Trip

Venice Power Plant of the Union Electric Company

9:30 a.m.

Applied Mechanics (III)

The Uniform Distribution of a Fluid Flowing Through a Perforated Pipe, by W. M. Dow, assistant to director of research, United Gas Pipe Line Company, Shreveport, La. (50—SA-14)

Thermal Effects in Calendering Viscous Fluids, by M. Finston, aeronautical engineering department, Massachusetts Institute of Technology, Cambridge, Mass. (50—SA-13)

Fluid Flow Through Porous Metals, by Leon Green, Jr., research engineer, and Pol Duwez, associate professor of mechanical engineering, California Institute of Technology, Pasadena, Calif. (50—SA-17)

9:30 a.m.

Production Engineering (I)—Machine Design (I)

Contour Turning, by K. T. Kuck, vice-president of engineering, The Monarch Machine Tool Company, Sidney, Ohio. (50—SA-8)

Contour Milling, by M. E. Martellotti, research engineer, Cincinnati Milling Machine Company, Oakley, Cincinnati, Ohio.

2:30 p.m.

Machine Design (II)—Production Engineering (II)

New High-Accuracy Cam-Contour Mill Design and Applications, by A. D. Gunderson, tool engineer, George Gorton Machine Company, Racine, Wis. (50—SA-7)

Motor Properties for Integral Design, by T. T. Woodson, engineer, appliance and merchandise department, General Electric Company, Bridgeport, Conn. (50—SA-4)

2:30 p.m.

Process Industries—Fuels (IV)

Measurement of Smoke With a Photoelectric Cell, by W. F. Stoecker, Locomotive Development Committee, American Locomotive Company, Dunkirk, N. Y. (50—SA-16)

High-Temperature Fluid Heating, by P. L. Geiringer, chief engineer, American Hydrotherm Corporation, New York, N. Y.

2:30 p.m.

Hydraulic—Petroleum (I)

A New Method for Bulk-Modulus Determinations, by S. Logan Kerr, consulting engineer, Philadelphia, Pa.; Lewis H. Kessler, professor, and Merrill B. Gamet, associate professor, Northwestern Technological Institute, Evanston, Ill.

Attenuation of Surges in Long Pipe Lines, by Milton Ludwig, Standard Oil Company of California, San Francisco, Calif.

7:00 p.m.

Banquet

Presiding: R. R. Tucker, professor, mechanical engineering, Washington University, St. Louis, Mo.

Speaker: Edwin G. Nourse, economist, Washington, D. C.

Subject: An Engineering Approach to Stabilized Prosperity

THURSDAY JUNE 22

9:00 a.m.

Inspection Trip

Anheuser-Busch, Inc.

Busch-Sulzer Bros., Division of Nordberg Manufacturing Company

9:30 a.m.

Fuels (IV)—Petroleum (II)

Innovations in Equipment and Underground-Mining Procedures at the Bureau of Mines, Oil-Shale Mine, Rifle, Colo., by E. D. Gardner, L. Schramm, and Emery M. Sipprelle, Chief, Oil Shale Mine Branch Bureau of Mines, Rifle, Colo. (50—SA-10)

Oil-Shale Extraction and Refining, by Boyd Guthrie, U. S. Bureau of Mines, Rifle, Colo. (50—SA-11)

9:30 a.m.

Boiler Feedwater Studies—Power (V)

Chemical Removal of Copper From Boilers, by R. G. Call and W. L. Webb, American Gas and Electric Service Corporation, New York, N. Y.

Phosphoric Acid Cleaning of Boilers, by T. E. Purcell, general superintendent, and S. F. Whirl, chief chemist, Power Stations Department, Duquesne Light Company, Pittsburgh, Pa.

9:30 a.m.

Production Engineering (III)—Machine Design (III)

Comprehensive Analysis of Motor Performance, by R. H. Schuman, The Warner and Swasey Company, Cleveland, Ohio. (50—SA-2)

The Stress Distribution in the Continuous Chip—A Solution of the Paradox of Chip Curl, by Erik K. Henriksen, head, materials processing department, college of engineering, Cornell University, Ithaca, N. Y. (50—SA-9)

12:00 noon

Joint Luncheon

St. Louis Post With American Ordnance Association

Toastmaster: James S. Busch, chairman, St. Louis Ordnance District, St. Louis, Mo.

Speaker: Col. James L. Walsh, president, American Ordnance Association, New York, N. Y.

Subject: Working for Peace

2:00 p.m.

Inspection Trip

McDonnell Aircraft Corporation

2:30 p.m.

Machine Design (IV)

Accurate Spring Counterbalancing, by W. S. Rouverol, lecturer in engineering design, College of Engineering, University of California, Berkeley, California. (50—SA-6)

Displacement Versus Time Characteristics of Hydraulic Actuators, by L. S. Linderoth, Jr., professor, mechanical-engineering department, Iowa State College, Ames, Iowa. (50—SA-5)

2:30 p.m.

Petroleum (III)

Metals for High-Pressure Hydrogenation Plants, by George A. Nelson, metallurgist, Shell Development Company, San Francisco, Calif. (50—SA-3)

2:30 p.m.

Cutting Fluids—Metal-Cutting Data—Bibliography and Production Engineering (IV)

The Effect of the Cutting Fluid Upon Chip-Tool Interface Temperature, by M. C. Shaw, associate professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.; J. D. Pigott, research engineer, The Draper Corporation, Hopedale Mass.; and L. P. Richardson, research engineer, Shell Research and Development Company, Emeryville, Calif.

An Analytical Evaluation of Metal-Cutting Temperatures, by K. J. Trigger and B. T. Chao, department of mechanical engineering, University of Illinois, Urbana, Ill. (50—SA-1)

FRIDAY, JUNE 23

9:00 a.m.

Inspection Trip

Synthetic-Liquid-Fuel Plant of U. S. Bureau of Mines

ASME National Nominations

THE 1950 Nominating Committee invites ASME members to appear at its open meeting, June 19, 1950, at the Hotel Statler, St. Louis, Mo., where the ASME 1950 Semi-Annual Meeting will be held. Members may present their views concerning candidates for the office of President, Regional Vice-President, and Director at Large any time from 10 a.m. to 12 noon, and from 2 p.m. to 4 p.m.

Lectures and Panel Discussions to Be Feature of OGP 1950 Conference

FOR its 22nd National Conference and Exhibit to be held at the Lord Baltimore Hotel, Baltimore, Md., June 12–16, 1950, the Oil and Gas Power Division of The American Society of Mechanical Engineers has garnered information on what is new, important, useful, and interesting in the Diesel power field and has invited experts to present it in a program of lectures, panel discussions, and technical sessions which promise to be one of the best in years. Rarely has so much timely information about one industry been presented for such pleasant assimilation.

Among the new things the Conference will hear will be the first public report on the design features of a unique radial Diesel, built by the Nordberg Manufacturing Company, and test data on the new Berry hydraulic transmission. Those who come to the Conference on the lookout for solutions to practical problems will be rewarded by the lecture series on corrosion to be delivered by experts on the subject.

Interesting Panel Sessions

Valuable experience will be exchanged freely during two panel discussions. In the first, engine builders, shipbuilders, and marine operators will swap ideas on the best drive for Diesel propulsion. In the second, fuel experts, plant superintendents, and Diesel builders will give the same treatment to the question of how to handle and burn heavy fuels economically.

Alternating with the technical features of the program will be pleasant interludes beginning with the welcome luncheon at which Walter Perkins, vice-president of the Koppers Company, will speak. On Tuesday, when the entire evening will be given up to a social hour and banquet, members will hear Admiral D. A. Clark, chief, Bureau of Ships, review the present and future use of Diesels in the Navy.

The feature event and one well worth attendance at the Conference will be a boat trip to the U. S. Naval Engineering Experiment Station, Annapolis, Md., leaving Baltimore on Wednesday morning. After a luncheon on board, the men will tour the internal-combustion and mechanical laboratories while the women visit the Naval Academy and the historic houses of Annapolis. The return to Baltimore will be a moonlight cruise with refreshments and dancing. An inspection trip on Friday will take members to the offices of the Baltimore Transit Company and to those of the Baltimore and Ohio Railroad.

To cover administrative costs of the Conference, a modest fee will be charged. This will cover the privilege of attending lectures and technical sessions and preprints of available technical papers.

The annual exhibit of Diesel engines and accessory equipment which has always been a big feature of OGP national conferences, will again be held this year.

Tentative Program

The tentative program follows:

MONDAY, JUNE 12

Noon

Welcome Luncheon

Speaker: Walter Perkins, vice-president, Koppers Company

Afternoon and Evening

Lecture series on Corrosion

TUESDAY, JUNE 13

Morning

Design Features of Nordberg Radial Diesel, by Emil Grieshaber, Nordberg Manufacturing Company and Donald I. Bohn Aluminum Company of America.

Principles of Foundation Design for Engines and Compressors, by Wallace K. Newcomb, Ingersoll-Rand Company

Afternoon

Panel Discussion

Subject: What Drive for Diesel Propulsion?

Evening

Banquet

Speaker: Admiral D. A. Clark, chief, Bureau of Ships

Subject: Use of Diesels in the Navy, Present and Future

WEDNESDAY, JUNE 14

All day

Inspection trip by boat to U. S. Naval Experiment Station, Annapolis, Md.

THURSDAY, JUNE 15

Morning

Starting Requirements of Diesel Engines on Locomotives, by F. H. Brehob, General Electric Company

The Berry Hydraulic Transmission, by A. G. Holmes, Mississippi State College, and O. D. M. Varnado, Berry Motors Inc.

Afternoon

Analysis of Exhaust Process in Four-Stroke Reciprocating Engines, by John D. Stanitz, Lewis Flight Propulsion Laboratory, NACA

The Future of Supercharging, by Carl F. Harms, Elliott Company

FRIDAY, JUNE 16

Morning

Panel Discussion

Subject: Heavy Fuels—How to Handle and Burn Them, Make Them Pay?

Inspection Trips

Shops of Baltimore Transit Company and Baltimore and Ohio Railroad

Tentative Program of ASME 1950 Applied Mechanics Conference

THE 1950 Annual Conference of the Applied Mechanics Division of The American Society of Mechanical Engineers will be held at Purdue University, Lafayette, Ind., June 22–24, 1950.

The tentative program follows:

THURSDAY, JUNE 22

Session I

Morning

Momentum and Mass Transfer in Coaxial Gas Jets, by Walton Forstall, Jr., research associate, and Ascher H. Shapiro, associate professor, mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Characteristics of Irrotational Flow Through Axially Symmetric Orifices, by Hunter Rouse, director, Iowa Institute of Hydraulic Research, State University of Iowa, Iowa City, Iowa, and Abdel-Hadi Abul-Fetouh, lecturer, college of engineering, Farouk El-Awal University, Alexandria, Egypt. (50—APM-11)

Temperature Distribution in a Steady, Laminar Preheated Air Jet, by Chia-Shun Yih, University of British Columbia, Vancouver, B. C., Can. (50—APM-5)

The Theory of Spring-Loaded Valves for Reciprocating Compressors, by Michael Costagliola, Great Neck, N. Y.

Session II

Afternoon

Plastic Biaxial Stress-Strain Relations for Alcoa 24S-T Subjected to Variable Stress Ratios, by Joseph Marin, professor of engineering mechanics, department of engineering mechanics, and B. J. Kotalik, graduate student, department of engineering mechanics, Pennsylvania State College, State College, Pa. (50—APM-16)

A Method of Numerical Analysis of Plastic Flow in Plane Strain and Its Application to the Compression of a Ductile Material Between Rough Plates, by R. Hill, head of solid mechanics section, British Iron and Steel Research Association; E. H. Lee, associate professor of applied mathematics, Graduate Division, Brown University, Providence, R. I.; and S. J. Tupper, experimental officer, Armaments Research Department, Ministry of Supply, England.

The Use of Skewed Rolls in Calendering Operations, by G. F. Carrier, professor of engineering, Brown University, Providence, R. I. (50—APM-10)

The Rolling Problem for a Strain-Hardening Material, by Alice Winzer, Brown University, Providence, R. I.

FRIDAY, JUNE 23

Session III

Morning

Natural Frequencies of Continuous Beams of Uniform Span Lengths, by Robert S. Ayre, acting associate professor, and Lydik S. Jacobsen, professor of mechanical engineering, Stanford University.

Transverse Vibration of a Two-Span Beam Under the Action of a Moving Alternating Force, by Robert S. Ayre, acting associate professor, and Lydik S. Jacobsen, professor of mechanical engineering, Stanford University. (50—APM-2)

Vibration of Rectangular Plates by the Ritz Method, by Dana Young, professor of engineering mechanics, University of Texas, Austin, Texas

Influence of Rotatory Inertia and Shear on Flexural Motions of Isotropic Elastic Plates, by R. D. Mindlin, professor of civil engineering, Columbia University, New York, N. Y.

Session IV

Afternoon

An Iterative Numerical Method for Nonlinear Vibrations, by John E. Brock, assistant professor of mechanics, Washington University, St. Louis, Mo. (50—APM-1)

Vibrations of Elastic Systems Having Hereditary Characteristics, by Enrico Volterra, associate professor of mechanics, Illinois Institute of Technology, Chicago, Ill. (50—APM-8)

Impact on a Multispan Beam, by William H. Hoppmann 2nd, assistant professor of mechanical engineering, The Johns Hopkins University, Baltimore, Md. (50—APM-15)

The Process of the Buckling of Elastic Columns, by N. J. Hoff, professor of aeronautical engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

SATURDAY, JUNE 24

Session V

Morning

Effect of Stress-Free Edges in Plane Shear of a Flat Body, by W. T. Read, Bell Telephone Laboratories, Inc., Murray Hill, N. J. (50—APM-6)

Elastic Torsion in the Presence of Initial Axial Stress, by J. N. Goodier, professor of theoretical and applied mechanics, Stanford University. (50—APM-4)

On the General Theory of Thin Shells, by William R. Osgood, Armour Research Foundation, Chicago, Ill., and Joseph A. Joseph, mechanical engineer, David Taylor Model Basin, Washington, D. C.

Session VI

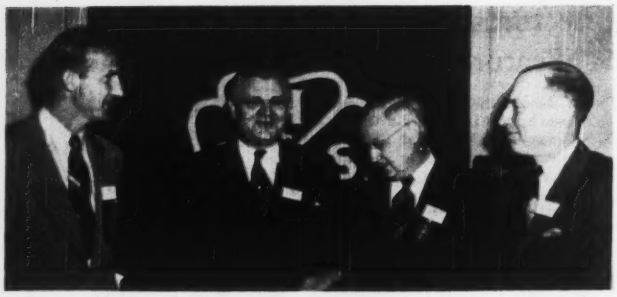
Afternoon

Stress Concentration Around Spheroidal Inclusions and Cavities, by R. H. Edwards, Playa del Rey, Calif.

Relaxation Process Applied to Stress Concentration in Fillets Due to Torsion, by John H. Huth, Berkeley, Calif.

The Stresses Around a Small Opening in a Beam Subjected to Pure Bending, by Joseph A. Joseph, mechanical engineer, David Taylor Model Basin, Washington, D. C., and J. S. Brock.

Torsion of a Circular Shaft With Longitudinal Notches, by H. Okubo, professor, Institute of High-Speed Mechanics, Tohoku University, Sendai, Japan. (50—APM-7)



AT THE REGION VIII MEETING, DALLAS, TEXAS, MARCH 30–APRIL 1

(*Left to right:* G. W. Beesley, vice-chairman of meeting; C. E. Davies, secretary, ASME; H. R. Pearson, chairman of meeting; C. J. Eckhardt, vice-president, ASME Region VIII)

Region VIII Enthusiastic Over Success of Three-Day Regional Meeting

REGION VIII of The American Society of Mechanical Engineers, composed of all or parts of the states of Colorado, New Mexico, Oklahoma, Kansas, Arkansas, Missouri, Louisiana, and Texas, held its first purely regional meeting in Dallas, Texas, March 30–April 1, 1950, and concluded that the regional-meeting idea provided a first-rate method for stimulating interest in Society affairs.

The idea of a regional meeting was first set in motion a couple of years ago, largely due to the support of Linn Helander, the first vice-president of Region VIII.

Dallas, Texas, was chosen as the location of this first Regional Meeting because of its central location. H. R. Pearson was chosen to be general chairman of the committee for planning the meeting, and working with him were the following committee members: Glyn Beesley, vice-chairman; C. H. Shumaker, Meetings and Papers; W. B. Gregory, Hotel; L. W. Cumber, Registration; A. R. Mozisek, Entertainment; C. A. Besio, Inspection Trips; F. C. Justice, Publicity; Stanley Patterson, Finance; J. W. Lacy, Student Activities; and Mrs. C. A. Cowles, Ladies' Activities.

Active participation of all six sections in the Region was an essential factor in the success of this venture. Each section chairman presided at one of the technical sessions or luncheons and helped in arousing interest in his section. In planning the papers, only those related to the technological interests and industrial problems of this particular section of the country were chosen, since this meeting was primarily regional in nature and differed from other national meetings in this respect.

More than 2100 advance registration cards were mailed to Region VIII members two weeks before the meeting and approximately 100 replies were received.

The meeting was endowed with the usual cheerful atmosphere of good weather in the Great Southwest. Total registration was over 250, of which 200 were from Region VIII.

Concurrent with the Region VIII Meeting in Dallas, a Student Conference of the schools in the southern tier of this region was held at Southern Methodist University. The students, of course, conducted their own program and were invited to all nonconflicting activities of the "elder" meeting. These two regional meetings made Dallas pretty well "ASME conscious." The Regional Administrative Committee meeting was also held during the same period.

From the opening address of welcome by Wallace Savage, mayor of Dallas, Thursday morning, until adjournment after the final technical session just before noon Saturday, the Conference moved along in excellent, well-planned fashion. A limited number of preprints of the papers are available and may be secured from the authors direct.

The group was fortunate in having James M. Todd, past-president ASME, on hand Thursday morning to give the opening address, "Dollars and Sense." Following the address, Guy B. Arthur, Jr., president of Management Evaluation Services, Inc., Toccoa, Ga., told how engineers could become salesmen in presenting their ideas to management.

Inspection trips to various Dallas industries were conducted Friday afternoon. The trips included visits to a local power plant and to aircraft, automotive, and soap-manufacturing establishments.

The high light of the meeting was the banquet Friday evening, attended by more than 200 engineers, wives, and students. The speaker was James D. Cunningham, president ASME, who spoke on "The Engineer's Civic Responsibility."

Papers in the fields of water conservation, wood deterioration in cooling towers, and

lubrication problems were presented at the third technical session Saturday morning, at which R. M. Seago, chairman of the New Orleans Section, presided.

One noteworthy phase of the meeting was the successful program arranged for visiting wives and guests. Thursday afternoon the women were entertained at a luncheon and ice show at one of Dallas' leading hotels. Friday morning a conducted tour of Dallas was concluded with a luncheon at one of the city's picturesque and fashionable country clubs.

Much of the success and personal satisfactions derived from this meeting is somewhat intangible. These intangibles are associated with mutual technical interests and problems, new and renewed friendships, and refreshed interests in the affairs of the Society. The tangible benefits of this Regional Meeting were self-evident in the excellent quality of papers.

The following comments on ways in which the meeting could have been improved were heard: More complete information on the availability and disposition of preprints of the technical papers would have been helpful. Some members would have liked to have more time for the discussion of each paper. Because of the full program of activities, preference was expressed by some persons for more opportunities to engage in what is popularly known as "bull sessions."

REPORTED BY ROBERT W. COX, Jun. ASME

Actions of the ASME Executive Committee

At a Meeting at Headquarters, March 28, 1950

A MEETING of the Executive Committee of the Council was held in the rooms of the Society, March 28, 1950. There were present: James D. Cunningham, chairman; Forrest Nagler, vice-chairman; F. S. Blackall, jr.; A. C. Pasini, and Ralph A. Sherman of the Executive Committee; H. E. Whitaker, Finance Committee, H. E. Martin (Organization Committee); E. G. Bailey, past-president; J. L. Kopf, treasurer, E. J. Kates, assistant treasurer; C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

Board on Technology

The following actions of the Board on Technology were noted: (1) To hold the 1951 Fall Meeting in Minneapolis, Minn.; 1952 Fall Meeting in Rochester, N. Y.; 1953 Fall Meeting in Columbus, Ohio; 1951 Process Industries Conference in Baltimore, Md.; (2) 1955 Annual Meeting at the Stevens Hotel, Chicago, Ill.; (3) that the Society cooperate wholeheartedly with the ASCE by holding a full-scale ASME meeting in conjunction with the ASCE centennial celebration in 1952; and (4) that nonmember students attending national meetings of the Society be charged a registration fee of $1.

Custodian Funds

Following a discussion of the value of establishing Custodian Funds by the various groups of the Society, the Committee voted to encourage this practice for all groups including Sections, with the understanding that the funds be expended to further activities within the purposes of the Society.

Codes and Standards

In connection with the meeting of the Technical Committee No. 1 on Screw Threads of the International Standardization Organization to be held in Paris, an appropriation from the Development Fund was authorized to assure that the Society could have a representative at the meeting who was thoroughly familiar with the project.

Dues-Exempt-Members Policy

Upon recommendation of the Board on Membership, it was voted to submit to Council at its June, 1950, meeting, a policy of limiting dues exemption to those who have paid dues for not less than 35 years in any class except student members, at not less than the age of 65 or who retire from regular work before that age.

Microfilming of ASME Publications

A contract was authorized with University Microfilms for reproduction of ASME publications on microfilm. Under the terms of the agreement, ASME will receive a copy of the microfilm without charge for deposit in the Engineering Societies Library and a royalty of 10 per cent on the sale price of all microfilms sold by University Microfilms.

Society Legislative Activities

A manual on Society legislative activities, prepared as a guide for Society groups who wish to take part in legislative problems affecting engineers, was approved. Copies are available on request.

Certificate of Award

A certificate of award was granted to George E. Hulse in recognition of his chairmanship of the Admissions Committee in 1948.

Guide for Junior Engineers

After reviewing the pamphlet "Professional Guide for Junior Engineers" published by the Engineers' Council for Professional Development, the Committee voted to make the pamphlet available to student members at half price and authorized several steps by which the pamphlet could be called to the attention of student and junior members.

Bulletin to Members

With reference to a bulletin on the Engineers Joint Council and the Engineers' Council for Professional Development authorized by the Council at its November, 1949, meeting, the Committee recommended allocation of funds to cover distribution of EJC and ECPD information to members.

National Water Policy

At the request of the Engineers Joint Council, it was voted to request the Finance Committee to appropriate funds for supporting the work of the EJC Committee on National Water Policy.

New Engineering Societies Building

It was noted that the United Engineering Trustees had a meeting with representatives of the Carnegie Endowment for International Peace to discuss the possibility of the Founder Societies joining as tenants or co-operative owners of a new building in the United Nations vicinity. Following consideration of the Founder Societies' office problems, the Committee voted to ask the United Engineering Trustees Real Estate Committee to look into the question of locating the Engineering Societies Headquarters in a central part of the country with respect to membership and industry and the desirability of dispersion from the standpoint of security.

The Gantt Medal

An allotment from the funds appropriated for awards was approved for support of the Gantt Medal for the next five years.

Appointments

The appointments to Committees and joint activities recommended by the Organization Committee were approved. The following members were named honorary vice-presidents for the Fourth World Power Conference to be held in London, July 10–15: C. B. Campbell, P. H. Chase, A. G. Christie, C. W. E. Clarke, F. P. Fairchild, Alf Kolflat, W. W. Kuyper, B. A. Landry, E. E. Parker, W. H. Rowand, W. C. Schroeder, George A. Stetson, Paul W. Thompson.

The following presidential appointments were confirmed: C. B. Campbell, W. J. Kinderman, as ASME representatives to the annual meeting of the American Academy of Political and Social Science; G. H. McCullough and H. Poritsky, to International Congress of Mathematicians; C. J. Freund, to Centenary Celebration, University of Dayton; and Arthur Roberts, Jr., to Dedication Ceremonies, University of Tennessee.

Section Activities

Connecticut Engineers Honored E. B. Gallaher

THE Fairfield Section of The American Society of Mechanical Engineers honored one of its distinguished members, Edward B. Gallaher, president, Clover Manufacturing Company, Norwalk, Conn., at a dinner in the Hotel Barnum, Bridgeport, Conn., Feb. 14, 1950.

A certificate of the Fellow grade to which Mr. Gallaher was elected in December, 1949, was presented to him by Frank M. Gunby, vice-president, ASME Region I. In making the presentation, Mr. Gunby reviewed briefly Mr. Gallaher's long career as a pioneer in the automobile, street-railway, and gas-engine industries, and more recently as president of a company producing a belt abrasive which has

ASME Calendar

of Coming Events

June 12–16
ASME Oil and Gas Power Division Conference, Lord Baltimore Hotel, Baltimore, Md.
(*Final date for submitting papers was Feb. 1, 1950*)

June 19–23
ASME Semi-Annual Meeting, Hotel Statler, St. Louis, Mo.
(*Final date for submitting papers was Feb. 1, 1950*)

June 22–24
ASME Applied Mechanics Division Conference, Purdue University, Lafayette, Ind.
(*Final date for submitting papers was Feb. 1, 1950*)

Sept. 18–22
ASME Instruments and Regulators Division Conference, Municipal Auditorium, Buffalo, N. Y.
(*Final date for submitting papers — May 1, 1950*)

Sept. 19–21
ASME Fall Meeting, Hotel Sheraton, Worcester, Mass.
(*Final date for submitting papers — May 1, 1950*)

Sept. 25–28
Petroleum Mechanical Engineering Conference, Hotel Roosevelt, New Orleans, La.
(*Final date for submitting papers— May 1, 1950*)

Oct. 23–25
ASME Fuels Division Conference, Hotel Statler, Cleveland, Ohio
(*Final date for submitting papers— July 1, 1950*)

Nov. 26–Dec. 1
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(*Final date for submitting papers— Aug. 1, 1950*)

April 2–5, 1951
ASME Spring Meeting, Hotel Atlanta Biltmore, Atlanta, Ga.
(*Final date for submitting papers— Dec. 1, 1950*)

April 17–19, 1951
ASME Process Industries Conference, Baltimore, Md.
(*Final date for submitting papers— Dec. 1, 1950*)

June 18–22, 1951
ASME Semi-Annual Meeting, Hotel Royal York, Toronto, Ont., Can.
(*Final date for submitting papers— Feb. 1, 1951*)

(*For Meetings of Other Societies see page 436*)

found wide acceptance in machine shops. Mr. Gallaher, he said, was author of the "Clover Business Letter," read by business executives for its helpful comments in the field of economics. He was recently honored by Stevens Institute of Technology with the honorary degree of doctor of engineering.

Mr. Gunby announced that Mr. Gallaher has offered to send the "Clover Business Letter" without charge to any member of the ASME who writes to him giving mailing address and company affiliations.

Following the presentation, Rudolph F. Bannow, president, Bridgeport Machines Inc., spoke on "Ten Thousand Milling Machines in Ten Years." Mr. Bannow was born and educated in Sweden. He commented on his experiences in establishing a machine-tool business in America, and expressed his gratitude for the opportunity which still exists in America. He was concerned, Mr. Bannow said, over the importation of European class struggles to America lest it stifle here, as it has in Europe, the freedom of opportunity.

The best interest of employers and employees lies in working together and understanding each other's problems. Unless understanding is achieved, opportunity in America may be destroyed, he said.

Engineers Cautioned on U. S. Technical Superiority

THE potential enemies of democracy are making remarkable progress in accumulating scientific knowledge and developing engineering techniques, according to Edwin Speakman, executive director of the Research and Development Board of the Department of Defense. He spoke at a joint meeting of the Metropolitan Section of The American Society of Mechanical Engineers, the New York district of the American Society for Testing Materials, and the 1996 Organized Reserve Research and Development Unit of the U. S. Army. The United States must prosecute vigorously its research and development program during peacetime if she hopes to maintain the technical superiority she now has in weapons and equipment for our fighting forces.

He said the Board's 500-million-dollar program represented a little more than one cent out of every federal tax dollar, or a little less than four cents out of every dollar spent by the Department of Defense. The Board feels, he said, that it has by no means achieved its full goal with respect to smooth operations and effective procedures.

Where adjustments in program emphasis and support are necessary in order to bring about a properly balanced program, the Board must make them with full consideration for over-all efficiency and national security, said Mr. Speakman. He added, however, that a great deal has been accomplished within the brief period of the Board's existence.

In discussing the general aspects of the Board's work and the research in electronic countermeasures against enemy radio signals in particular, Mr. Speakman shed some light on the escape of the German battle cruisers, *Gneisenau*, *Scharnhorst*, and *Prinz Eugen*, through the English Channel from Brest during World War II.

ASME FLAG, A 20TH ANNIVERSARY GIFT TO STUDENT BRANCH

(This ASME flag was presented to the student branch at the University of Delaware by the Wilmington Subsection in a joint meeting on March 15, 1950, to symbolize the constant interest of the Subsection in the students. The flag will be displayed during days on which student-branch meetings are held. Looking at the bulletin board is J. Richard Swanson, student ASME, who made the casting supporting the flag. The charter certificate was presented to the branch in its twentieth year on Dec. 12, 1949, by Justin J. McCarthy, chairman, Region III Committee on Student Branches. The scene is in the main corridor of Evans Hall, the University engineering building.)

ASME 1913 Tour of Germany Recalled at Toronto Section

HARRY VERCOE HAIGHT, retired consulting engineer, Canadian Ingersoll-Rand Co., Ltd., was presented The American Society of Mechanical Engineers 50-year button by Albert C. Pasini, vice-president, ASME Region V, at a Toronto Section dinner meeting held at Hart House, Toronto, Ont., Can., March 9, 1950.

In Mr. Haight's acceptance speech he told of his experiences as an engineer and of the travels his work with Ingersoll-Rand entailed. He spoke about the 1913 trip to Germany made by 209 ASME members to meet with the Verein deutscher Ingenieure and to tour industrial Germany and showed some of his souvenirs of the tour.

The group visited the shipyards of Blohm and Voss in Hamburg where the *Vaterland* was under construction.

Other German engineering works inspected were the Borsig Works, the Thyssen and Company works, Heniel and Luag, the Humboldt Engineering Company, and the works of Pokorney and Wittekind.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York 8 West 40th St. | **Chicago** 84 East Randolph Street | **Detroit** 100 Farnsworth Ave. | **San Francisco** 57 Post Street

MEN AVAILABLE[1]

MECHANICAL AND INDUSTRIAL ENGINEER, 41, seventeen years' experience in engineering projects as plant engineer, master mechanic, and superintendent in both industry and mining. Foreign experience in Latin America. Knowledge of Spanish. Knowledge of civil engineering and construction projects. Available now. Me-684.

MATERIALS-HANDLING ENGINEER, 28, BSME, MSIE, married. Broad experience in unit load systems, cost studies, etc., presently conducting development project on materials-handling equipment. Desires connection with manufacturer or consultant. Me-685.

MECHANICAL ENGINEER, BME, 1949, four and a half years' experience, layout automatic machinery, electromechanical devices. Presently employed. Seeks responsible position involving stress, motion analysis, vibrations, machine design. Pursuing master's ME. Me-686.

MECHANICAL ENGINEER, 26, married, BSME, 1949. Presently employed in laminated-plastics development. Prefer position in design, development, and testing of heat-power equipment as junior engineer. East. Me-687.

MECHANICAL ENGINEER, BSME, June 1949. University of Connecticut, 25, single, veteran. Desires position in air conditioning, industrial engineering, or management. Will travel or locate anywhere. Me-688.

MECHANICAL ENGINEER, graduate, 28, registered engineer, bilingual, married. Wide experience maintenance, conveyerization, modernization production methods and tooling, administrative abilities, full knowledge woodworking, furniture finishings. Actually on general superintendent's position, Quebec, Canada. Available immediately. Me-689.

MECHANICAL ENGINEER, 29, married, BSME, five years methods and process engineering, one and a half years factory engineering. Desires work in above or willing to train in maintenance or service. Prefers N. E., upper N. Y. Me-690.

MECHANICAL ENGINEER, registered Pennsylvania; Cornell, 1943. Experience: power plant—specifications; requisitions; instrumentation; heat balances; boiler and turbine installation; process—pump and heat-exchanger calculations; flow diagrams; plant maintenance. Assistant plant engineer. Me-691.

MECHANICAL ENGINEER, 27, BS, single, willing to travel. Desires location in New England or Northwest, in medium-sized plant of diversified manufactures. Marine-instrument field service and automatic-machinery background. Me-692.

INSTRUMENT ENGINEER, BME, married. Seven years' experience; four years in application-engineering department of large industrial instrument manufacturer. Desires supervisory position in instrument section of a process industry. Will consider foreign assignment. Me-693.

RECENT GRADUATE, married, 23, BSME, University of California, 1947. Currently employed, one year's experience drafting, machine design. Will consider any attractive offer, preferably engines or power-plant equipment. Will relocate. Me-694.

EXECUTIVE ENGINEER, 44, BSEE, registered ME, desires position as factory manager. Well-rounded experience in production management; industrial engineering; product, tool and machine design; metal stampings, sheet-metal work, assembly, small-arms ordnance, and heavy machinery. Will relocate. Me-695.

MECHANICAL-ENGINEERING GRADUATE, 1949, 24, electrical-manufacturing experience, good electronics background, attending law school evenings. Desires position in valuation, patents, trade association, or contracts. New York, N. Y. area. Me-696.

MECHANICAL ENGINEER, BME, June graduate, 27, married, four years' power-plant experience as marine engineer, holding first assistant steam and third assistant Diesel licenses, some export experience; speaks Italian and Spanish; desires sales, installation, or maintenance work. Will go abroad. Me-697.

MECHANICAL ENGINEER, four and a half years' precollege aircraft-maintenance experience. BME, 26. University of Minnesota, December, 1949. Me-698.

MECHANICAL ENGINEER, BS, Columbia, 1949. New York State engineer in training, 26, single, veteran. Courses in time-motion, methods, labor relations, personnel. Aggressive, personable, leader type. Will relocate. Me-699.

MECHANICAL ENGINEER, 28, BSME, married. Experience includes aircraft-engine installations (reciprocating, turbojet, and ramjet), servomechanisms, thermodynamics, hydrodynamics, design of test instrumentation, and external representation work for company. Available immediately. Me-700.

MANUFACTURING ENGINEER, BSME, Purdue 1935, fifteen years' diversified experience in organization and administration of production and industrial engineering in metalworking industries, including tool-and- die designing and making, equipment procurement, plant layout, materials handling, production and material control, budgets, etc. Me-701.

MECHANICAL ENGINEER, master's degree, Yale, June, 1950, 24, married, one year industrial experience. Seeks position in design or research. Will locate anywhere. Me-702.

MECHANICAL ENGINEER, BME, NYU, 27 single. Diversified experience in management, construction, sales, writing, inspection, and radar. Tau Beta Pi, Pi Tau Sigma. Will travel or relocate. Me-703.

TIME AND MOTION ENGINEER experienced in plant layout (considering man-machine complements), job analysis, and rate setting in machine shop, packing room, assemblying, and shipping departments. Me-704.

POSITIONS AVAILABLE

SAFETY ENGINEER, 35-40, mechanical or chemical-engineering graduate, with at least ten years' plant and safety-engineering experience in chemical-process industry, to supervise safety program in chemical plant. $5400-$6000. Northern New Jersey. Y-3377.

MECHANICAL ENGINEER with at least five years' experience in design and layout of machinery and processing equipment, to design and lay out process equipment, steam boilers, power plants, etc. A knowledge of Spanish preferred. Occasional trips to plants in Central and South America. Salary open. Connecticut. •Y-3381.

CHIEF TOOL-DESIGN ENGINEER with considerable experience in tool designing on aircraft instruments and accessories. $7500-$8000. Northern New Jersey. Y-3400.

INDUSTRIAL ENGINEER, 28-45, with minimum of five years' experience, preferably with industrial-management firm. Some traveling. $7000-$8000. New York, N. Y. Y-3406.

ASSISTANT QUALITY-CONTROL MANAGER, 35-45, with at least ten years' supervisory experience covering machine-shop production in automotive or mass-production allied industry, to take charge of inspection, improve methods, and perform liaison duties with engineering, purchasing, etc. $10,000. East. Y-3412.

DESIGNER-DRAFTSMAN, chemical or mechanical, with a minimum of five years' experience on the design, calculation, layout of mixing equipment, such as blowers, etc., as used in chemical plants. $5000-$6000. Ohio. Y-3420.

[1] All men listed hold some form of ASME membership.

PROJECT ENGINEER, 30-40, experienced on petroleum and/or gas equipment. Must be able to assume supervision of, and responsibility for, entire section. No recent graduate considered, as position entails immediate responsibility. Pennsylvania. Y-3429.

PLANT ENGINEER, mechanical background, 40-45, experienced in food handling or products where sanitation is an element, requires knowledge of tanks, piping, refrigeration, heat exchange, construction methods, installation, and modification of major plant equipment, facilities, and construction. $7000-$8000. Midwest. Y-3446-R-6136.

CHIEF MECHANICAL ENGINEER, 40-50, to supervise mechanical department of about 100 men. Must have had considerable experience in power-plant field. $10,000-$11,000. New York, N. Y. Y-3462.

PRODUCT OR CHIEF ENGINEER, 35-45, for manufacturer of small precision machine tools. Capable of directing engineering projects and supervising product designers and development engineers. Must know tooling and production methods. Shop background desirable. Up to $15,000. Missouri. R-6077.

DESIGNER, 35-45, mechanical engineer, with ten years' experience with complete design problems encountered in redesigning present line and designing new line of centrifugal pumps. Must be able to accept ideas and work them up, investigate competitive and existing line and develop changes of assembly, machining, and product, leading to improved product, reduced costs, greater customer appeal for a manufacturer. $6000-$6600. Illinois. R-6310.

PLANT SUPERINTENDENT, up to 50, mechanical engineer, completely experienced with assembly line high-speed production of small and medium-size close-tolerance metal manufacturing and assembling; able to supervise all production departments, provide engineering for tools, jigs, and fixtures, develop production planning, scheduling, and control, have knowledge of time study and costs, be informed regarding production methods and machinery. Salary open. Illinois. R-6313.

SALES MANAGER, 34-39, mechanical, with ten to fifteen years' experience with sale of industrial equipment to users and distributors. Will direct sales engineering, develop advertising and promotion, contact dealers, in national sales organization for a manufacturer of electric trucks. $10,000-$14,000. Midwest. R-6317.

PLANT ENGINEER, under 40, electrical or mechanical training, to act as assistant to general manager. Knowledge of steam, electric, water-utilities distribution, and steam generation, electrical conversion, able to figure costs, determine efficiencies, supervise operating and maintenance personnel, and tradesmen for a management company in an industrial building. $5200. Illinois. R-6336.

CHIEF ENGINEER, up to 45, mechanical graduate, with at least five years' experience operating high-pressure boilers, chain-grate, and automatic coal-fired. Must have operating engineer's license. Able to supervise operation and maintenance of boiler room of large office building. To $6000. Illinois. R-6342.

DESIGN-DEVELOPMENT ENGINEER, mechanical, with two years' direct or closely related experience with components of air-borne radar equipment. Considerable layout and some board work. Salary open. Indiana. R-6361(b).

Student Loan Fund

THE Woman's Auxiliary to The American Society of Mechanical Engineers maintains a student loan fund from which students of mechanical engineering enrolled in an accredited college may borrow as much as $300. Applicants must be recommended by the dean of engineering and endorsed by two other responsible persons.

Engineering students interested in the loan should write to Mrs. Franklin H. Fowler, Jr., The American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after May 25, 1950, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

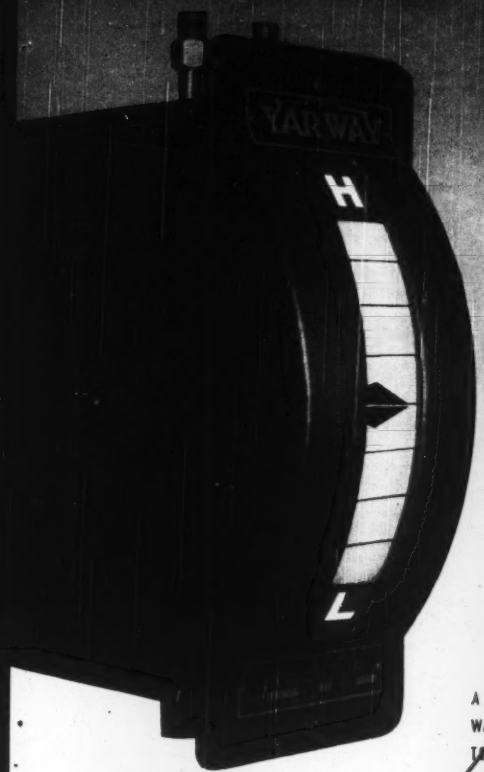
For Member, Associate, or Junior

ACKERSON, COLIN W., Milwaukie, Ore.
ADAMS, JOHN B., Bound Brook, N. J.
AGUIRRE, GUSTAVO, Buenos Aires, Argentina
ALLISON, DEAN M., Madison, Wis.
APPLE, JAMES M., E. Lansing, Mich.
ARNALL, FRANKLIN H., Texas City, Texas
BARRON, MARTIN L., Wilmington, N. C.
BELKIN, MORTON, Bayside, N. Y.
BLOCK, ALFRED C., Cambridge, Mass.
BOHLE, F., Chicago, Ill.
BOLING, RONALD W., Hendersonville, N. C.
BONI, FRANK, JR., Cuyahoga Falls, Ohio
BOWDITCH, ROBERT P., Charleston, W. Va.
BULLARD, RONALD E., Syracuse, N. Y.
CAMPBELL, NEAL P., San Francisco, Calif.
CHAMBERLIN, WILLIAM E., San Francisco, Calif.
CHAN, HANAN, New York, N. Y.
CHRISTIE, DAVID H., N. Tonawanda, N. Y.
CLANCY, RUSSELL J., Woodland Hills, Calif.
CONSALVI, ANTHONY L., Philadelphia, Pa.
CORNELIUS, EARL M., JR., New Castle, Pa.
CORY, WILLIAM J., Norman, Okla.
COWLES, W. A., JR., New York, N. Y.
DAVIS, RICHARD E., Portland, Ore.
DIXON, GLENN R., East Alton, Ill.
DONALDSON, JAMES G., Rochester, N. Y.
DONLON, GROVER PETER, Chicago, Ill.
DOYLE, JOHN T., Greenwich, Conn.
FERGUSON, G. F., Boston, Mass.
FLEMING, ROBERT W., Madison, Wis.
FLOYD, MONROE, Houston, Texas
FRIZELL, CHARLES E., Randolph, Mass.
FRYE, JOHN H., Akron, Ohio
GREENLEES, JAMES C., JR., Philadelphia, Pa.
GRIGGS, CLIFTON A., JR., Hinsdale, N. H.
GROSS, ROBERT R., Grosse Pointe, Mich.
HANFORD, E. F., Hammond, Ind.
HARBECK, CLIFFORD F., Putnam, Conn.
HARDIN, GORDON D., Louisville, Ky.
HENDERSON, CLARK, Palo Alto, Calif.
HEIM, ARTHUR I., Albertson, N. Y.
HERBATY, FRANK, Woodmere, N. Y.
HERMAN, A. DALE, Encino, Calif.
HICKS, LEWIS F., Athens, Ohio
HIGGINS, WALLACE L., Yokosuka, Japan
HOWE, LLOYD G., Toronto, Ont., Can.
HUNT, RICHARD E., Ridley Park, Pa.
IVINS, EARL EDWARD, Long Beach, Calif.
JACKSON, HERBERT, Signal Mountain, Tenn.
JEROME, J. WILLIAM, JR., Chicago, Ill.
JONES, THOMAS JOHN, Steubenville, Ohio
KERCHER, CHARLES E., JR., Akron, Ohio
KIBBEY, MEAD B., Sacramento, Calif.
KILLGORE, ELLIS M., Lisbon, La.
KING, RICHARD C., Garrett, Ind.
KLUG, HAROLD H., Cleveland Heights, Ohio
KODAT, ERVIN B., Chicago, Ill.
KRENZIN, ROBERT, Hurricane, W. Va.
KUHN, JOHN, Buffalo, N. Y.
KUTTRUFF, LOUIS CARL, Baton Rouge, La.
LALA, THEODORE J., New Orleans, La.
LANE, ALEXANDER M., S. Ozone Park, N. Y.
LANG, PAUL A., Elizabeth, N. J.
LEE, JAMES F., Cleveland, Ohio
LEPPERT, GEORGE, St. Louis, Mo.
LILES, HUGH A., New Orleans, La.
MAAG, ARTHUR W., Buffalo, N. Y.
MACDONALD, CHARLES L., New York, N. Y.
MACMILLAN, DONALD B., Matawan, N. J.
MCDOWELL, JOSEPH H., Spencer, N. C.
MCLAUGHLIN, DONALD H., Los Angeles, Calif.
METTER, CHARLES WILLIAM, Hatboro, Pa.
MJOLSNES, LEONARD O., Unadilla, N. Y.
MONGITORE, JAMES, Lynbrook, N. Y.
MURDOCK, JAMES W., Philadelphia, Pa.
MURPHY, HUGH W., Lambertville, N. J.
MUSCARELL, ROBERT V., Fairlawn, N. J. (Rt & T)
OLSON, EVERETT A., Beloit, Wis.
PARADISE, L. ALVIN, New Castle, Pa.
PASSAGE, DONALD B., Leonia, N. J.
PHELPS, DUDLEY F., Brooklyn, N. Y.
PLATT, LAWRENCE A., Edwardsville, Kans. (Rt & T)
POPOVICH, MILOSH, Corvallis, Ore.
PRIORE, PHILIP J., JR., Charleston, W. Va.
PRUST, HERMAN W., JR., Altamont, N. Y.
RAY, FRANCIS A., Baltimore, Md.
REYNOLDS, ELBERT B., JR., State College, Pa.
ROARK, L. E., Chicago, Ill.
ROBIRDS, WILLIAM ROLAND, El Dorado, Ark.
ROLL, ROBERT RALPH, Terre Haute, Ind.
ROTH, WALTER J., Alliance, Ohio

(*ASME News continued on page 448*)

A COMPLETE SYSTEM...

FOR INSTANT, ACCURATE CHECK ON LIQUID OR BOILER WATER LEVELS THROUGHOUT THE PLANT



Yarway Remote Liquid Level Indicator with Control Unit attached.

Now you can have constant check-up on water levels wherever —and whenever—you want.

The Yarway Liquid Level Indicator, equipped with Yarway Control Unit and auxiliary electric signalling devices, provides this check at two or more locations anywhere in the plant.

The Yarway Indicator is always accurate because it is operated by the liquid itself. Indicating mechanism is never under pressure. There are no stuffing boxes. Complete separation of indicating and actuating parts is achieved by permanent magnet transmission.

The Automatic Control Unit is attached directly to the Indicator and operates the remote signal alarms (light or horn) at any remote locations.

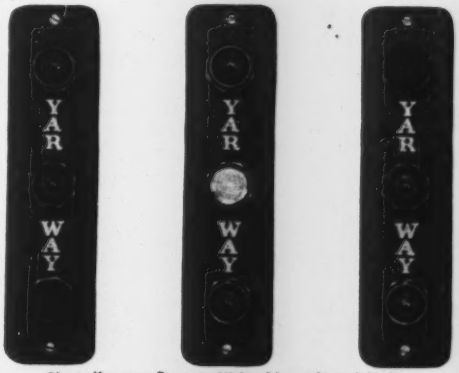
The Control Unit may also be used as a control for mechanical equipment such as motor-operated valves, pumps, etc.

FOR COMPLETE DESCRIPTION AND SPECIFICATIONS OF YARWAY REMOTE LIQUID LEVEL INDICATORS, WRITE FOR BULLETIN WG-1822.

YARNALL-WARING COMPANY
108 Mermaid Ave., Philadelphia 18, Pa.

NEW!
A RECORDING BOILER WATER LEVEL INDICATOR—THE YARWAY HI-LO-GRAPH. SEE BULLETIN WG-1830.

Yarway Remote Hi-Lo-Alarm Signal Horns.



Three Yarway Remote Hi-Lo-Alarm Signal Lights, showing low level, normal operation and high level. Each unit shows all levels.

YARWAY REMOTE LIQUID LEVEL INDICATOR

SCHMELZER, HANS, Montreal, Que., Can.
SHEPARDSON, DONALD W., Rochester, N. Y.
SHEPPARD, EDWARD K., Charlotte, N. C.
SIME, HOWARD LEWIS, Sacramento, Calif.
SIMS, W. NORMAN, Philadelphia, Pa.
SMITH, GEORGE A., Erie, Pa.
SPANNHAKE, ERNST W., Chicago, Ill.
STOLL, HENRY W., Rochester, N. Y.
SVOBODA, LLOYD J., Kansas City, Kans.
TALBERT, JOHN E., Glen Rock, N. J.
TEEL, ROY M., Bartlesville, Okla.
VANDER.GRACHT, FERNAND, Rose Valley, Pa.
VICKROY, JOHN S., Dallas, Texas
WARNER, DONALD G., Rochester, N. Y.
WASHINGTON, WILLIAM H., JR., Cornelia, Ga.
WAYNE, HARRY B., Brooklyn, N. Y.
WEBER, WILLIAM H., Richmond Heights, Mo.
WILKIN, L. A., E. Chicago, Ind.
WILLIAMS, JAMES B., York, Pa. (Rt&T)
WILLIAMS, LOUIS H., Troy, N. Y.
WINER, JOSEPH H., Spring Valley, N. Y.
WING, RAYMOND F., Allentown, Pa. (Rt&T)
WINSLOW, FRANK E., Baltimore, Md.

CHANGE IN GRADING

Transfers to Member and Associate

CRAMER, ROBERT J., JR., Hales Corners, Wis.
GALLMEYER, WILLIAM C., Grand Rapids, Mich.
GREEN, W. A., JR., Richmond, Va.
HALZEL, GEORGE C., Dorchester, Mass.
HAPPEL, HERMANN E., Indianapolis, Ind.
HAUG, JOHN R., Boston, Mass.
JERNBERG, EVERT H., Minneapolis, Minn.
KNOWLES, D. W., Toronto, Ont., Can.
LEE, RICHARD W., Hamilton, Ont., Can.
O'BRIEN, HUBBERT L., E. Chicago, Ind.
SANDLAND, CLIFFORD M., San Marino, Calif.
SEBAN, RALPH A., El Cerrito, Calif.
SHERWOOD, A. WILEY, College Park, Md.
SUTHERLAND, WILLIAM H., Hoboken, N. J.
SWIFT, JUDSON J., Brooklyn, N. Y.
SYBERT, WARREN M., Brooklyn, N. Y.
THOMAS, JOHN A., Montreal, Que., Can.
VAN SAUN, W. G., Janesville, Wis.
VOGEL, ARTHUR P., New York, N. Y.
WILEY, J. N., Great Neck, N. Y.
WILTROUT, ROBERT E., JR., Akron, Ohio
WOERSCHING, THOMAS B., Towson, Md.
YOUNG, FREDERICK L., JR., York, Pa.

Transfers from Student Member to Junior . . . 25

Obituaries

Leon Bellamy (1870–1949)

LEON BELLAMY, president, Bellamy Engineering Co., Newtonville, Mass., died April 2, 1949, at his home in Newtonville. Born, Ithaca, N. Y., Aug. 21, 1870. Parents, Charles Lucius and Harriet Leonice (Thompson) Bellamy. Education, public schools. Married Carrie Delina Bulkley, 1898 (died 1941). Mem. ASME, 1914. Survived by a daughter, Dorothy Thompson B. (Mrs. George W.) Eychishymer, 2nd, and two grandsons.

Benjamin Henry Blaisdell (1871–1948)

BENJAMIN H. BLAISDELL, retired mechanical engineer, died Sept. 30, 1948. Born, Goffstown, N. H., Jan. 25, 1871. Education, graduate, Minneapolis High School; University of Minnesota. Mem. ASME, 1909.

Edwin Stimble Boyer (1875–1950)

EDWIN S. BOYER, retired in 1946, chairman of the board, American Hard Rubber Co., New York, N. Y., died at Muhlenberg Hospital, Plainfield, N. J., Feb. 21, 1950. Born, Philadelphia, Pa., April 17, 1875. Parents, Erwin and Rose (Stimble) Boyer. Education, University of Pennsylvania. Married Bertha E. Leslie, 1899. Jun. ASME, 1897; Assoc. ASME, 1902; Mem. ASME, 1907. Survived by wife and son, E. Leslie Boyer.

Lemuel Newton Burhoe (1887–1949)

LEMUEL N. BURHOE, general superintendent, Riverside Metal Co., Riverside, N. J., died Dec. 8, 1949. Born, Charlottetown, Prince Edward Island, Can., Sept. 26, 1887. Parents, William and Kathrine Hannah Burhoe. Education, BSEE, Norwich University, 1911. Naturalized, Boston, Mass., 1908. Married Zetta Davis Merchant, 1892; children, Robert D. and John M. Mem. ASME, 1937.

Frederic Newell Bushnell (1867–1950)

FREDERIC N. BUSHNELL, retired, former vice-president, director, Stone and Webster Engineering Corp., Boston, Mass., died in his home at Brookline, Mass., Jan. 23, 1950. Born, Saybrook, Conn., May 15, 1867. Parents, Richard M. and Sarah (Overman) Bushnell. Education, graduate, Morgan High School; special courses in mathematics. Married Ida R. Simpson. Recipient of the New England Award of the Engineering Societies of New England, 1945. Mem. ASME, 1891; Fellow ASME, 1937. Served the Society as Manager, 1917–1920. Survived by wife and son, Richard S., Boston, Mass.

Ernest John Cambou (1918–1949)

ERNEST J. CAMBOU, electrical engineer, General Electric Co., Los Angeles, Calif., died in Santa Rosa, Calif., Aug. 13, 1949. Born, San Francisco, Calif., Feb. 20, 1918. Parents, John and Marie Cambou. Education, ME, University of Santa Clara, 1940. Married Eugenie Balthazar, 1941. Jun. ASME, 1940. Survived by wife and two sons, John and Donald; and his parents.

Albert Bennett Cudebec (1879–1950)

ALBERT B. CUDEBEC, vice-president, Hydropress, Inc., New York, N. Y., died of a heart attack in Philadelphia, Pa., Jan. 28, 1950. Born, Nunda, N. Y., Nov. 5, 1879. Parents, Clarence L. and Almeada (Bennett) Cudebec. Education, CE, Cornell University, 1908. Married, Ora Ruth Moe, 1900, daughter. Cevira. Legion of Honor, France; Academie Française, Officier, was recipient of many war decorations and citations from the U. S. A. and several foreign governments for his services during World War I as a member of General Pershing's staff. Mem. ASME, 1941. Survived by wife and daughter, Mrs. Edward A. Rose, New York, N. Y.

William Noble Dickinson (1872–1950)

WILLIAM N. DICKINSON, plastics engineer, Supply Manufacturing Co., New York, N. Y., died Jan. 26, 1950. Born, New York, N. Y., June 20, 1872. Parents, William Noble and Mary Elizabeth (Coleman) Dickinson. Education, Pratt Institute; Polytechnic Institute of Brooklyn. Married Bertha B. McCall, 1922, son, Bradley. Mem. ASME, 1935. Served the Society as chairman, Materials Handling Committee and House Committee; member, ASME Medal Committee. Fellow AIEE. Survived by wife and son; and sister, Louise M. Dickinson, Brooklyn, N. Y.

Henrik Ivar Verner Edenholm (1901–1949)

HENRIK IVAR VERNER EDENHOLM, head of the steam-engineering department, The Royal Institute of Technology, Stockholm, Sweden, died Feb. 16, 1949. Born, Goteryd, Sweden, Aug. 19, 1901. Parents, Ernest and Hulda (Svensson) Edenholm. Education, ME, Tekniska Hogskolan, Stockholm, 1924. Married Anna Greta Petrini, 1926. He received the Vasaorden (Swedish), 1947. Survived by wife and four children, Karin, Ernest, Ulla, and Barbro.

Hilbert Ephraim Edwards (1902–1949)

HILBERT E. EDWARDS, section engineer, laundry-equipment engineering development department, Westinghouse Electric Corp., Mansfield, Ohio, died Dec. 16, 1949. Born, Ridgeville, Ohio, Oct. 5, 1902. Parents, Herbert and Alma (Stevens) Edwards. Education, ICS, 1926. Married Jean Fyfe Guild, 1922. Mem. ASME, 1945. Survived by wife and three children, James Herbert, Columbus, Ohio; William Howard and Barbara Ellen, Mansfield, Ohio.

Charles Hust Fox (1860–1950)

CHARLES H. FOX, nationally recognized authority on piston pumps and fire apparatus, died at his home in Hyde Park, Cincinnati, Ohio, Jan. 26, 1950. Born, Cincinnati, Dec. 16, 1860. Parents, Herman and Catherine Fox. Education, public schools. Married Ella Geist, 1910. Chosen Modern Pioneer of research and invention in 1940 by the National Association of Manufacturers. Mem. ASME, 1900. Survived by wife and stepson, Ralph E. Hoffmeister, Cincinnati, Ohio.

Charles Graham Herbert (1869–1949?)

CHARLES G. HERBERT, whose death was recently reported to the Society, was retired in 1921 as chief engineer, Solvay Process Co. Born, London, England, Sept. 26, 1869. Parents, Walter and Elizabeth G. Herbert. Education, St. Marks College, Chelsea, London, England. Naturalized, Syracuse, N. Y., Feb. 18, 1895. He was married and the father of four children, Irene G., Elizabeth S., Arthur S., and Charles W. Mem. ASME, 1900.

Charles Gunnar Holmberg (1880–1950)

CHARLES G. HOLMBERG, retired tool-and-gage design engineer, died at Westfield, N. J., Jan. 26, 1950. Born, Norrkoping, Sweden, Sept. 5, 1880. Parents, Karl Gunnar and Alma Holmberg. Education, mechanical-engineering course, Ebberstein's Mechanical Institute, Sweden, 1900. Naturalized, 1900. Married Mary Sophie, 1908. Mem. ASME, 1928. Survived by wife and son, Charles G., Milwaukee, Wis.; and two grandchildren.

William Van Antwerp Kemp (1890–1948)

WILLIAM V. A. KEMP, retired consulting engineer, died in Westport, Conn., March 17, 1948. Born, New York, N. Y., Nov. 19, 1890. Parents, William Van Antwerp and Fannie (Allen) Kemp. Education, BA, Williams College, 1911; ME, M.I.T., 1913. Married Caroline Riker, 1918. Mem. ASME, 1925. Survived by wife.

Serge Peter Kovaleff (1899–1949)

SERGE PETER KOVALEFF, vice-president and general sales manager, Enterprise Engine and Foundry Co., San Francisco, Calif., died at his home in Burlingame, Calif., Oct. 4, 1949.

(*ASME News continued on page 450*)

SHOPPING FOR BLOWERS?

Type OIB Centrifugal Blower in midwestern chemical plant. Capacity 19,600 cfm.

CENTRIFUGAL

Look at *R-C dual-ability* with its wide selection to suit almost any job

Asking Roots-Connersville about blowers, exhausters and gas pumps has been standard practice among buyers for almost a century. That's because building such equipment is the only job we do. We're outstanding specialists in handling gas and air.

You'll gain from our wide varieties of sizes, types and capacities from 5 cfm to 100,000 cfm. We're the only manufacturers offering you the *dual-choice* between Centrifugal and Rotary Positive designs—and that *dual-ability* is important when it comes to matching the units to the jobs to be done.

So—when shopping, be sure to call on Roots-Connersville, the specialists. When you're interested in vacuum pumps, meters or inert gas generators, we're equally well-fitted to fill these needs, too.

ROOTS-CONNERSVILLE BLOWER CORPORATION
505 Michigan Avenue, Connersville, Indiana

Rotary Positive Blower used for pneumatic conveying in eastern food manufacturing plant.

ROTARY

ROOTS-CONNERSVILLE

BLOWER BUILDERS SINCE 1854

ONE OF THE DRESSER INDUSTRIES

DOING ONE THING WELL FOR ALMOST A CENTURY

Born, Rovnoe, Russia, June 18, 1899. Parents, Peter Jacob and Anna (Borodina) Kovaleff. Education, BS, University of California, 1926. Naturalized, Aug. 7, 1933. Married Alexandra Tearo, 1926. Mem. ASME, 1945. Survived by wife and two children, Anna S. and Alexis S.

Mathew Gregory Krivor (1908–1950?)

MATHEW G. KRIVOR, whose death was recently reported to the Society, had served with the Economic Co-Operation Administration in North China. Born, Vladivostock, Russia, June 17, 1908. Education, ME in EE, Polytechnical Institute, Harbin, Manchuria, 1931. Mem. ASME, 1949.

Herbert Bamford Langille (1871–1950)

HERBERT B. LANGILLE, associate professor emeritus, mechanical engineering, University of California, died in Berkeley, Calif., Feb. 9, 1950. Born, Tusket, Nova Scotia, Jan. 27, 1871. Parents, James Leander and Sarah Fine (Harding) Langille. Education, AB in ME, Stanford University, 1915. Married Teresa M. Conroy, 1898. Mem. ASME, 1915. Served the Society as San Francisco Section, chairman, 1934–1935, and secretary-treasurer, 1937–1940. Fellow AAAS. Survived by wife.

Joseph Nisbet LeConte (1870–1950)

JOSEPH N. LECONTE, professor emeritus, mechanical engineering, University of California, died at his home in Carmel, Calif., Feb. 2, 1950. Born, Oakland, Calif., Feb. 7, 1870. Parents, Joseph and Caroline E. (Nisbet) LeConte. Education, BS, University of California, 1891; MME, Cornell University, 1892. Married Helen Marion Gompertz, 1901 (died 1924); children, Helen Malcolm and Joseph. Married 2nd, Adelaide E. Graham, 1929. Received LLD, University of California, 1945. Author, "Mechanics of Machinery" and "Hydraulics." Mem. ASME, 1906.

William Keith McAfee (1893–1950)

W. KEITH MCAFEE, chairman of the board, Universal-Rundle Corp., Redlands, Calif., was killed in an airplane crash, near Quincy, Fla., Feb. 2, 1950. Born, Pittsburgh, Pa., Jan. 26, 1893. Parents, James and Winifred (Harrington) McAfee. Education, BSEE, University of Pennsylvania, 1915. Married Katharine Kirk, 1920. Honorary degree ceramic engineer, N. Y. State School of Ceramics, Alfred University, 1935. Assoc.-Mem. ASME, 1923; Mem. ASME, 1931. Fellow AAAS. Survived by wife and two sons, Robert Keith and William Keith.

William Fairlie McNear (1904–1950)

WILLIAM F. MCNEAR, instructor, mechanical engineering and drafting, Stevens Institute of Technology, died at Presbyterian Hospital, Newark, N. J., Feb. 21, 1950. Born, Newark, N. J., Dec. 11, 1904. Parents, Alexander Sutherland and Euphemia (Fairlie) McNear. Education, ME, Stevens Institute of Technology, 1926. Married Dorothy McGraw, 1935. Jun. ASME, 1942; Mem. ASME, 1946. Survived by wife and daughter, Janet Louise, and his mother.

Otto Nonnenbruch (1885–1949)

OTTO NONNENBRUCH, sales engineer, The Baldwin Locomotive Works, New York, N.Y., died Nov. 22, 1949. Born, Munich, Germany, Dec. 8, 1885. Parents, Max and Margarethe Nonnenbruch. Education, Diplom Ingenieur, Technische Hochschule, 1910. Naturalized, Boston, Mass., 1923. Married Ruth Libbey, 1930. Mem. ASME, 1922. Survived by wife.

Edward Thornton Penrose (1917–1949)

EDWARD T. PENROSE, senior technician, oceanography, was accidently killed in his laboratory at Wood's Hole (Mass.) Oceanographic Institute, on Oct. 8, 1949. Born, Milton, Mass., April 2, 1917. Parents, Walter Edward and Eleanor G. (Canning) Penrose. Education, BSME, Tufts College, 1939; U. S. Naval Academy, 1941; Diesel engineering school, North Carolina State College of Agriculture and Engineering, 1941. Was Lieutenant Commander, U.S.N.R., discharged from the service, 1946. Married Patricia Ruth Baldwin, 1946. Jun. ASME, 1939. Survived by wife and daughter, Pamela Patricia.

Ralph Waldo Rogers (1881–1949)

RALPH W. ROGERS, retired designing engineer, Chicago Pneumatic Tool Co., Franklin, Pa., died Dec. 2, 1949, at his home in Tidioute, Pa. Born, Frostburg, Md., June 28, 1881. Education, BSME, University of West Virginia, 1902. Married Ethel I. Ingraham, 1906. Mem. ASME, 1914. Survived by wife and four daughters, Mrs. Thomas Draffin, Brooklyn, N. Y.; Mrs. A. W. Eisenman, Mrs. L. L. Dinniny, and Joy Rogers; and six grandchildren, all of Bradford, Pa.

Ralph I. Shields (1896–1950)

RALPH I. SHIELDS, superintendent, Pacific Portland Cement Co., Redwood City, Calif., died Jan. 13, 1950. Born, Eureka, Calif., Dec. 29, 1896. Parents, John and Elida Shields. Education, graduate, Eureka High School. Married Alva M. Simas, 1925. Mem. ASME, 1932. Survived by wife and two children, Marilyn B. and John H.

Clement Fawcett Street (1862–1948)

CLEMENT F. STREET, retired consulting engineer, died at his home in Kings Park, L. I., N. Y., on Nov. 11, 1948. Born, Salem, Ohio, July 13, 1862. Parents, David and Eunice (Fawcett) Street. Education, Ripon (Wis.) College. Married, Elizabeth Fawcett, 1887 (died 1932). Was awarded the John Scott Medal by The Franklin Institute. Survived by daughter, Martha, Atlantic City, N. J.

Alvin Robert Walker (1915–1949)

ALVIN ROBERT WALKER, mechanical engineer, Radiation Laboratory, University of California, died Aug. 13, 1949, at Berkeley, Calif. Born, St. Paul, Minn., Dec. 31, 1915. Parents, Robert Evan and Laura Ester (Brodeur) Walker. Education, BSME, University of California, 1938. Married Marjorie Marie Brown. Jun. ASME, 1938. Survived by wife and his parents, of Fresno, Calif.; and a sister, Ethel L. Musselman, Fresno, Calif.

Carl Frederick Westerberg (1860–1949)

C. FREDERICK WESTERBERG, retired chief draftsman, American Tube and Stamping Plant, Stanley Works, Bridgeport, Conn., died Dec. 12, 1949. Born, Kalman, Smaland, Sweden, April 8, 1860. Education, graduate, technical school, Norrkoping, Sweden. Naturalized, Oct. 18, 1888. Married in 1887, wife deceased, children, Elsa Viola, Elna F., Carl E., Helga F., Frederick S., and Leslie A. Mem. ASME, 1922.

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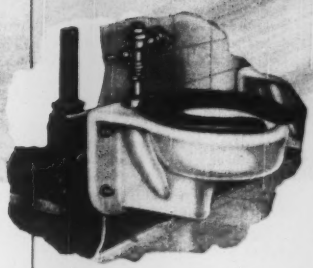
OF INSTALLING WALL TYPE CLOSETS IS THE EASY, FAST, SAFE WAY

NEW *Zurn Catalog and Handbook No. 50 on Wall Closet Fittings and Carriers for Wall Type Fixtures*

Carrier Catalog and Handbook No. 50



The Zurn Way lifts fixtures up off the floor—frees them from support of the wall. Both the floor and the fixture are more easily and quickly cleaned. Wall type toilet facilities are more sanitary and reduce maintenance cost.

THE NEW ZURN Carrier Catalog and Handbook No. 50 is the only complete and authoritative book on when, where and how to install wall type fixtures. It's a time-saver—leaves nothing to be guessed at! It is virtually a manual for the specification, buying and installing of all types and makes of wall fixtures. Write for a copy now! You'll be needing it! No charge to architects, engineers and contractors.

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JENKINS PRACTICAL PIPING LAYOUTS 50

CODE	QUAN.	JENKINS VALVES	SERVICE
A	1	Fig. 92 — Bronze Sw. Check	Prevent System Backflow to Water Supply
B	1	Fig. 47 — Bronze Gate	Water Supply to Closed System
C	1	Fig. 47 — Bronze Gate	System Connection to Expansion Tank
D	1	Fig. 92 — Bronze Sw. Check	Prevent Reverse Flow to Pump
E	1	Fig. 106-A — Bronze Globe	Pump Discharge Regulation
F	2	Fig. 47 — Bronze Gate	Heat Exchanger Shut off
G	1	Fig. 106-A — Bronze Gate	Flow Control to Individual Cooling Coils
H	1	Fig. 47 — Bronze Gate	Warm Water Return Shut Off
J	1	Fig. 47 — Bronze Gate	Pump Suction Shut off
K	2	Fig. 106-A — Bronze Globe	Drain Valves
L	1	Fig. 106-A — Bronze Globe	Pressure Gage Control
M	1	Fig. 106-A — Bronze Globe	Air Cushion Release
N	1	Fig. 106-A — Bronze Globe	Pump Vent

CLOSED EXPANSION TANK PIPING CONNECTIONS

To provide for changes in system water volume (due to water temperature variations), an expansion tank is used in water heating or cooling systems. The tank may be of the open, vented or (as illustrated) closed type. The latter has the advantage, in that it can be located anywhere in the system. Layout shows it tied into discharge side of circulating pump.

Supply valve is left open throughout filling operation. Water fills entire system compressing the air in expansion tank. When tank pressure equals that of supply water the supply line check valve closes automatically.

As system water cools and contracts, pressure drops below that of supply water, opening check valve until pressures equalize. Should system water temperature rise too high, a relief valve opens, draining water back into tank, compressing the air to above water supply pressure. A check valve prevents water flow back into supply line.

Consultation with accredited piping engineers and contractors is recommended when planning any major piping installations.

VALVE RECOMMENDATIONS
For details and valves to suit varying conditions see Jenkins Catalog

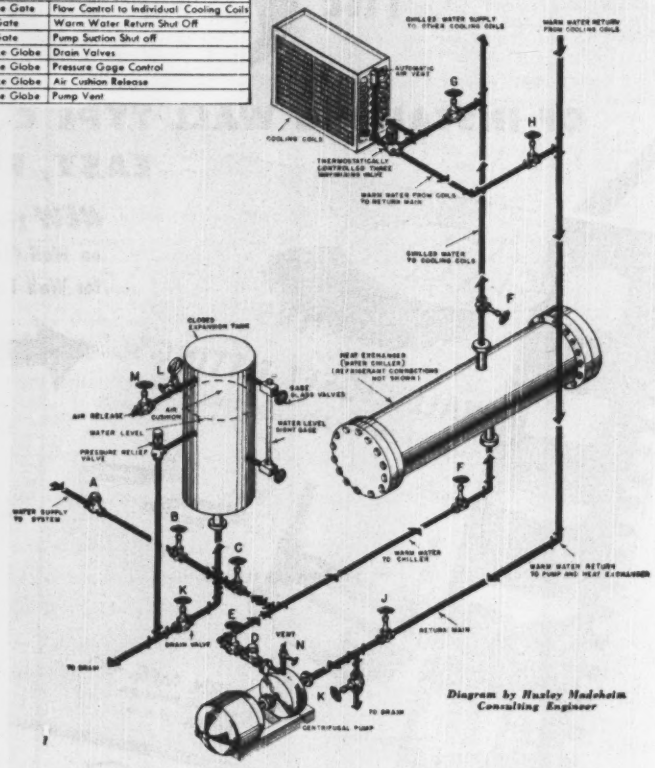

Diagram by Huxley Madeheim Consulting Engineer

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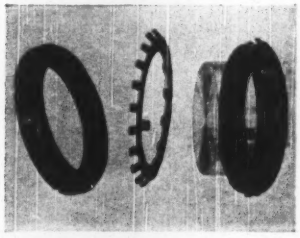
• NEW EQUIPMENT

Link-Belt Announces Line of Bearing Positioning Locknuts and Lockwashers

Link-Belt Co. announces the manufacture of a line of bearing-positioning locknuts and lockwashers, specially designed for effectively locking the various makes of ball and roller bearings in correct position on shafts of $^{5}/_{16}$ to $7^{11}/_{16}$ inches diameter.

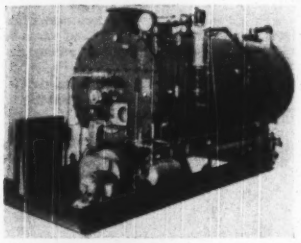


Advantages claimed are—precision manufacture to A.B.E.C. and S.A.E. standards; attractive appearance; easy to install and remove; rust-resistant; vibration proof; smooth, burr-free.

Detailed dimensions are contained in a 4-page illustrated Folder No. 2348, which will be sent to any interested reader upon request.

Self-Contained 15 to 500 Hp Boilers

An addition to its complete line of self-contained 15 to 500 horsepower boilers has been announced by the Cleaver-Brooks Co., Milwaukee, Wis.



The new unit, called the Model LR, a pacemaker in modern boiler design and construction, makes more effective use of today's low-cost fuels, heavy oils and gas, according to the maker.

Included among the model's features is a rotary burner, simple, compact and fully automatic, which provides unprecedented flexibility in burning heavy oils or industrial gases. A single, low-speed, low-power consumption blower furnishes all the air for combustion. This results in less weight and reduction in sound levels.

A totally enclosed, drip- and dust-proof panel protects all major electrical controls. Electronic combustion safety devices and dual low-water cutoffs are standard equipment. The simplified design of a combination gas-oil burner permits rapid changeover from oil to gas or the reverse in less than a minute.

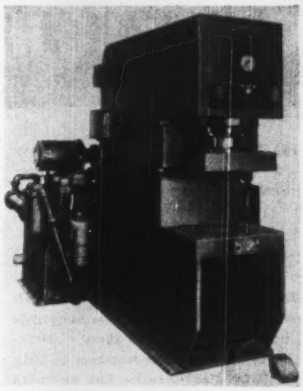
The Model LR is a boiler of all-welded construction, meeting standards of the A. S. M. E. boiler code, leading insurance underwriters and burners approved by Underwriter's Laboratory.

Of a highly developed four-pass fire tube design, the Model LR is tested and proved by factory and field experience on several thousand boilers of this type.

Further information on the Model LR can be obtained by writing Cleaver-Brooks, 345 East Keefe Ave., Milwaukee, Wis., for Catalog SG-142.

New Elmes Openside Press Has 3-Way Operation

Development of a new Elmes Openside Hydraulic Press is announced by the Elmes Engineering Div. of American Steel Foundries.

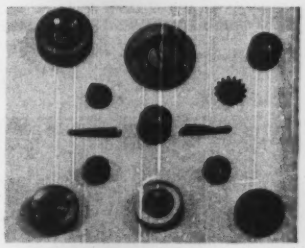


This press, originally designed for a prominent manufacturer of farm implements, performs 3 operations per cycle—shearing, riveting, and straightening on forged steel parts—at 35 cycles per minute. Since the work handled is subject to variations in thickness, multiple operations performed on a single press stroke require precise applications and accurate regulation of pressure. These characteristic features of hydraulic power have been utilized by Elmes engineers in designing a press which turns several troublesome, costly procedures into one smooth, fast, profitable operation.

The press has a moving platen, 18" × 16" and 3" stroke. High and low pressure pump provides rapid advance, slower pressing speed and rapid return. Photo-electric safety control stops platen immediately if obstruction breaks light beam at entrance to dies. Accessible, fast, flexible. Sizes and capacities can be provided for all service needs.

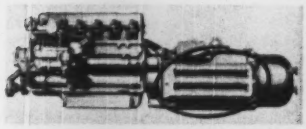
Complete engineering details and cycle description of this new press—also Catalog 1010-B, "Hydraulic Metal-Working Presses"—will be sent promptly on request. Address American Steel Foundries, Elmes Engineering Div., Cincinnati 29, Ohio.

Greater Detail and More Complex Shapes Now Possible Economically in Parts Made of Cemented Carbide



As a result of advances in manufacturing methods, many of the limitations have now been removed which formerly existed with regard to economical production of special shapes of parts made of cemented tungsten carbide. At the Industrial Cost-Cutting Exposition in Philadelphia, Carboloy Co., Inc., Detroit 32, exhibited a number of unusual shapes, some of which are illustrated above, to indicate design variations now possible with ultra-hard wear-resisting carbides. They include wear resistant parts, router bits, embossing dies and lettering stamps all having rather intricate shapes. Note the detail and definition on the feathers of the Indian's head-dress, for example.

Corrugated Flexible Metal Hose Used as Heat Exchanger

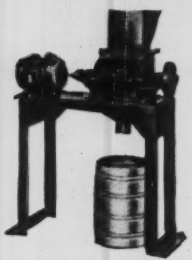


In an unusual application of flexible metal hose, Chicago Metal Hose Corp. Rex-Weld Corrugated Hose, Type RW-90, has been incorporated into the design of Waukesha Diesel "Enginators" as heat exchangers for generator cooling air. The "Enginator",

Continued on Page 42

from TEST GRINDING to TONNAGE CRUSHING

AMERICANS are custom-built to do a better job!



AMERICAN Laboratory Size Mills
With the same reduction action as Metal Turnings Crushers (or hammer action)—American Laboratory Size Mills offer an efficient means for reducing razor blades, pewter castings and fragile, thin brittle steel to a reclaim product.

AMERICAN Metal Turnings Crushers
Bulky, hard-to-handle turnings are rapidly reduced as much as 80% with this efficient, economical crusher. And the yield of cutting oil is increased 30 to 50 gallons per ton—proof of how profitable the installation of an American Metal Turnings Crusher can be for those who handle 20 tons or more of metal turnings a month.

There's a custom-built AMERICAN for your operation—write for further data and specifications.

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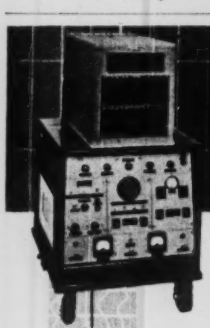

NEW HIGHS IN RESOLUTION

The Hathaway SC-16A Six Element Recording Cathode-Ray Oscillograph, designed for recording fast transients and continuous phenomena, brings you new highs in resolution because of its unusually high frequency response and high chart speed. Note these unusual features:

FREQUENCY RESPONSE 0 to 200,000 cycles per second • RECORDS up to 1000 ft. long at speeds up to 600 inches per second • RECORDS up to 10 ft. long at speeds up to 6000 inches per second • WRITING SPEED above 100,000 inches per second • SIX ELEMENTS with interchangeable lens stages for 1, 2, 3, or 6 traces on full width of chart • INTERCHANGEABLE RECORD MAGAZINES for continuous recording or short records of fast transients • PRECISION TIMING tuning fork controlled QUICK-CHANGE TRANSMISSION for 16 record speeds • AUTOMATIC INTENSITY CONTROL • CONTINUOUS SWEEP OSCILLATOR

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Write for Bulletin 2G1-A-K

Hathaway INSTRUMENT COMPANY
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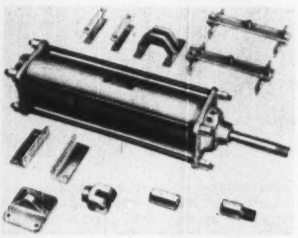
• Keep Informed

which consists of a unitized diesel engine-generator set, is designed to be mounted under railway cars to provide a constant source of electricity whether the train is standing or in motion. The CMH Rex-Weld Corrugated Flexible Metal Hose is mounted on the side of the generator and cooling air circulated through it. The air within the flexible metal hose is completely enclosed and is never mixed with outside air, thus giving protection against moisture, road dust and the elements. The corrugated hose offers substantial cooling surface, yet requires a fraction of the space a conventional heat exchanger would require.

Further information regarding the use of CMH Rex-Weld Flexible Metal Hose as a heat exchanger will be furnished by the manufacturer, Chicago Metal Hose Corp., Maywood, Ill.

Air and Hydraulic Cylinders

A new line of air and hydraulic cylinders, known as the Medium Duty Series, is announced by Ledeen Manufacturing Co. of Los Angeles, Calif. These cylinders are an addition to the line of Heavy Duty and Super Duty cylinders now being manufactured, which have found use in all industries wherever straight line motion is used; for remote control operation, material handling, clamping or holding, and a multitude of other uses.



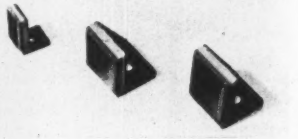
Cylinders utilize tie-rod construction to give positive protection against leakage at joint of tube and head. Chevron packing is used to seal piston rod. Synthetic cups and automatic cushion are standard construction.

Like the Heavy Duty companion series, these cylinders feature manufacture to completely standardized design, and to be carried in stock for immediate shipment. Various head and rod attachments provide for almost universal mounting requirements.

The three series of cylinders now offer an exceptionally wide selection and may be of special interest to original equipment manufacturers.

For information or literature, write to Ledeen Manufacturing Co., 1600 So. San Pedro St., Los Angeles 15, Calif.

Coal Pulverizer Blades of Carbide Metal Multiply Life Many Times



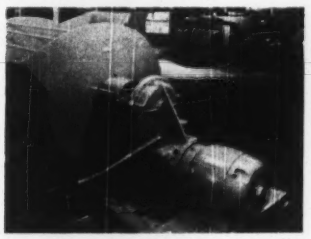
Ultra-hard cemented carbides are entering many new fields in the form of parts designed to reduce wear and tear, machine maintenance, and so on. In addition to its

• Keep Informed

recent invasion of the mining field in the form of shock and wear resistant drills, etc., the metal, according to Carboloy Co., Inc., Detroit 32, is now being used also in coal pulverizers forming a part of stoker installations produced by Riley Stoker Co., Worcester, Mass. Conventional pegs or blades in such pulverizers normally are good for about 3500 tons. Riley now uses forged steel pegs faced with Carboloy cemented carbide and says that the first installations have already passed the 22,000 ton mark with no appreciable wear on the blades. Carboloy facings are brazed to the pegs with Easy-Flo #3. They are produced in different sizes (as shown above), some of the Carboloy blade facings measuring around 4" square. A large number of the blades are used in each pulverizer.

G-E Electric Drive Applied to Plaster Mixers

The Essick Manufacturing Co., Los Angeles, Calif., one of the world's largest manufacturers of plaster and mortar mixers, has developed an electric drive for use on its Deluxe and "Thru-A-Door" Deluxemixer models.



The new driving power for the mixers is provided by a General Electric Tri-Clad* single-phase capacitor motor, rated at 3 hp, 1720 rpm, 115/230 v, 60 cycles. Power is transmitted from the motor to the paddle-shaft of the mixer through a completely enclosed transmission, running in oil. A gear reduction unit reduces the speed so that the paddles turn at 34 rpm.

Addition of the electric drive mixer to its line now permits operation in otherwise inaccessible quarters, and enables the Essick Manufacturing Co. to offer a plaster and mortar mixer for virtually every purpose.

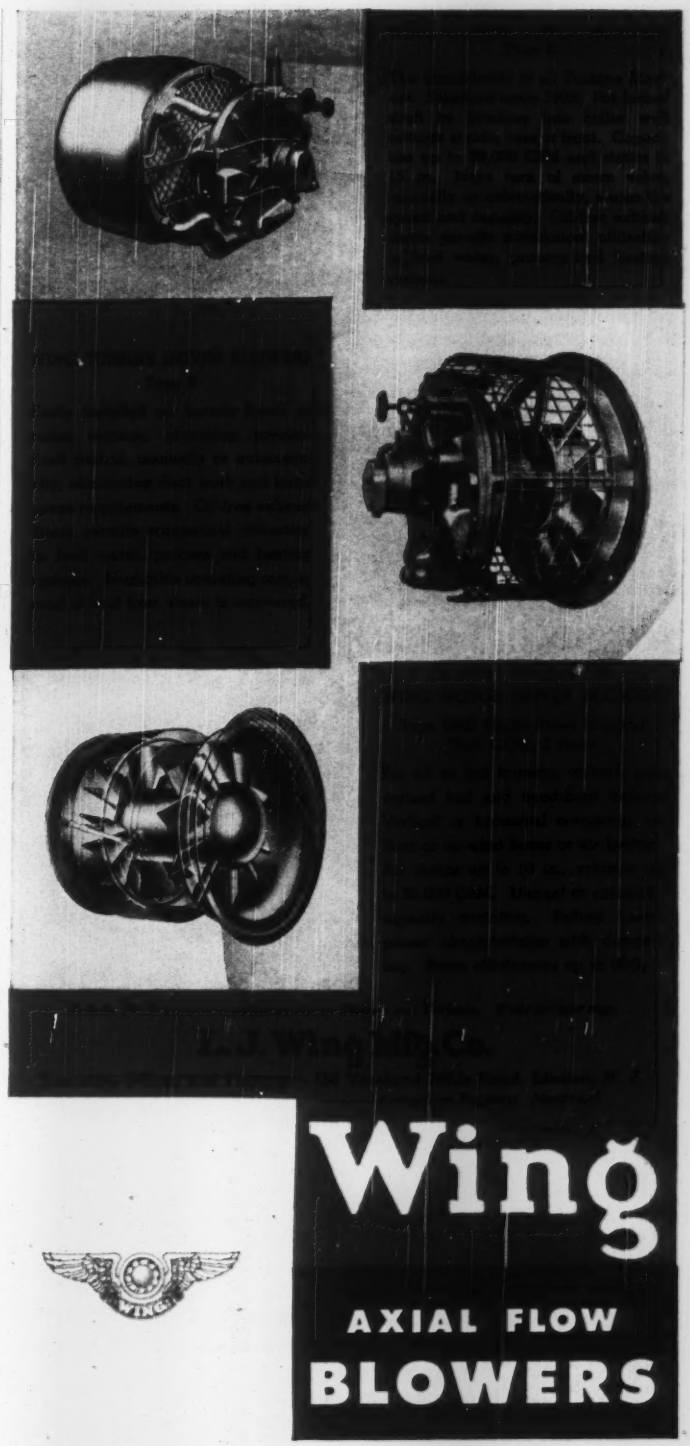
* Reg. U. S. Pat. Off.

Controlled Pipeline Expansion

Expansion and contraction caused by temperature changes in pipelines are controlled by packless, in-line, corrugated Expansion Joints. Joints are available in two types—Controlled-Flexing joints with control rings for high pressure; Free-Flexing joints without control rings for lower pressures.

These compact joints are especially suited for trenches, tunnels and other locations where space is at a premium. Joints are completely maintenance-free and make manholes in underground installations un-

Continued on Page 44



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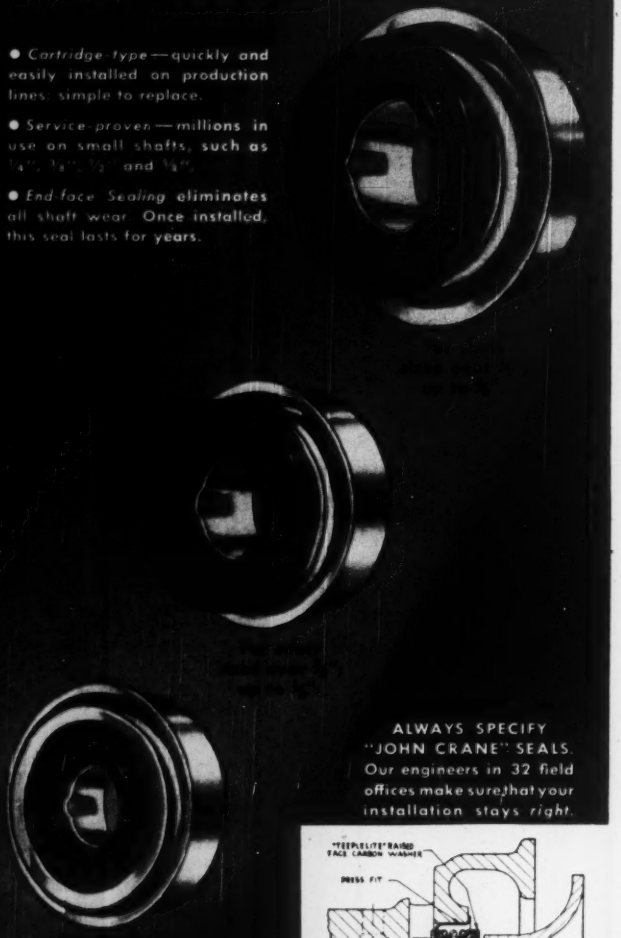
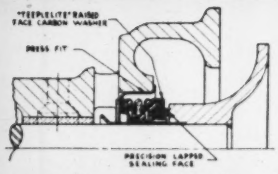


ALWAYS SPECIFY "JOHN CRANE" SEALS. Our engineers in 32 field offices make sure that your installation stays *right*.



Typical water-pump assembly

JOHN CRANE

PACKINGS AND MECHANICAL SEALS

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necessary. Used instead of pipe bends, they eliminate the cost of extra pipe needed for the bends, insulation cost of this extra pipe and expensive heat loss due to extra pipe surface.

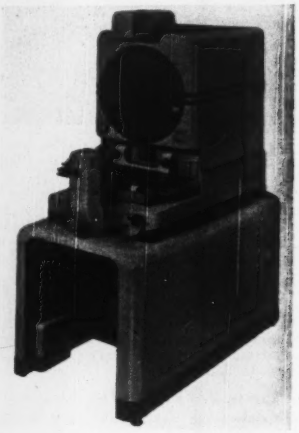
Joints of copper, stainless steel, or other alloys, are available in complete size range—from 3″ I.D. to 24″ I.D. Units are fabricated with single or multiple corrugations and with or without control rings. May be had with flanged or welding ends. Units with stainless steel inner liners, tie rods and special flanges and welding combinations available to meet individual installation requirements.

Axial pipeline traverse of $7\frac{1}{2}$″ can be controlled with a single Controlled-Flexing joint—traverse of 15″ in a single pipe run can be had with a "dual" Controlled-Flexing joint. A "dual" joint consists of two joints joined by an inter-connecting nipple. Lateral motion of $\frac{1}{16}$″ per corrugation, or a maximum offset of 1″ can also be handled. Joints operate under pressures to 300 p.s.i. and temperatures to 1600°F.

For further information, write Chicago Metal Hose Corp., Expansion Joint Div., 1305 South Third Ave., Maywood, Ill.

New Contour Projector Announced by Kodak

A new contour projector which provides greater working space for efficient staging was demonstrated for the first time at the Tool Engineers Industrial Exposition at Philadelphia.



Known as the Kodak Contour Projectors, Model 2, the new optical comparator provides a full $14\frac{3}{4}$ inches of work space between the lamphouse and lens, regardless of magnification. In addition, the work table of the new model has been enlarged to 20 inches in length and vertical travel has been increased from 2 to 4 inches.

As in Kodak's earlier contour projector, eight inches of space is provided between the object under inspection and the first lens of the projection system, while additional work space has been gained by relocating the lamphouse. The lamphouse has also been redesigned and can be swung down to permit surface inspection of long objects which extend far out in front of the instrument.

Surface projection with the new instrument is also made easier by a mirror attachment which provides surface or blind hole illumination in any of five planes.

A further change in the new model is the inclusion of a ball-bearing mounted, six-

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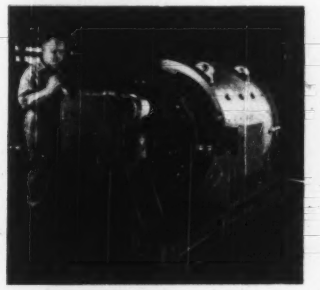
station lens turret permitting instant selection of any of six magnifications by turning a handwheel. Lenses available for the turret are made in 10x, 20x, 31.25x, 50x, 62.5x, and 100x magnifications. All lenses are corrected to produce a distortion-free image giving exact magnification over the entire 14-inch screen.

600 H.P. Calender Drive Motor

This 600-hp, 300/450-rpm calender drive motor, believed to be the largest of its kind built to date, has been shipped by Allis-Chalmers Manufacturing Co. to a Midwestern manufacturer where it will be used to produce tire ply at the fastest rate in the rubber industry.



With its supporting motor-generator set, this motor is part of an integrated electrical drive for the calender and its auxiliary equipment. It is designed with a low Wk^2 so that emergency calender roll stops can be made within the guaranteed value of 14 inches of calender roll travel from the full load speed of 450 rpm. This corresponds to 100 yards per minute of the calender roll.

The motor, which will drive the calender at speeds of eight to 100 yards per minute, is equipped with a bearing temperature relay, geared tachometer and speed limiting device.

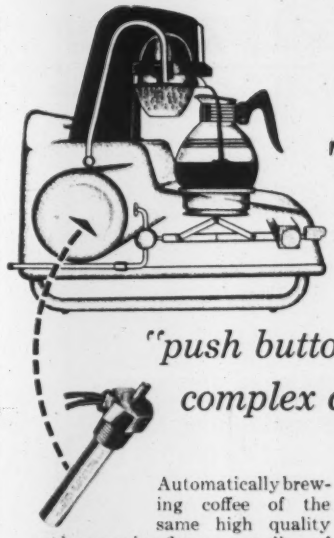
The supporting motor-generator set consists of a 500-kw, 600-volt d-c generator driven by a 703-kva, 80% pf, 2,300-volt, 900-rpm synchronous motor. It, too, is equipped with bearing temperature relays and speed limiting device.

New De Laval General Service Process Pumps

The new De Laval Type CP Pumps are designed expressly for the hundreds of general service applications in the process industries that require handling hot or cold clear liquids, viscous liquids, corrosive liquids of liquids carrying suspended solids. They are furnished with open or closed impellers, mechanical seals or conventional packing, and vane characteristics and materials of construction can be selected to suit requirements.

These pumps have many operating and maintenance advantages. For example: To compensate for wear at the impeller face,

Continued on Page 46



Only the Thermoswitch* Control

solves "push button" coffee maker's complex control problems

Automatically brewing coffee of the same high quality and unvarying flavor, regardless of climate or altitude, the new Cory "Push Button" Coffee Brewing System involves exact control of coffee, water and infusion time. Most important of all, the supply tank's electric heater must be turned on and off with precision accuracy so that water will be constantly available at the best coffee brewing temperature.

Tests proved that only a THERMOSWITCH* Thermostat possessed the extreme sensitivity and instant response necessary to meet the Cory Automatic Coffee Brewing System's exacting requirements and load conditions.

Throughout industry, rapidly increasing THERMOSWITCH* unit applications are putting temperature control on a more efficient, more economical basis. Chances are, a standard THERMOSWITCH* unit will be fully adequate for your own needs. You'll find the cost of *all* THERMOSWITCH* units surprisingly low!

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I am chiefly interested in the applications checked:

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- ☐ Incubators
- ☐ Vulcanizing
- ☐ Pasteurizing

COOLING
- ☐ Refrigeration
- ☐ Ventilation
- ☐ Quick freezing

PROCESSING
- ☐ Canning
- ☐ Cooking
- ☐ Refining

SAFETY WARNINGS
- ☐ Engines
- ☐ Motors
- ☐ Transformers

DOMESTIC HEATING
- ☐ Limit switches
- ☐ Oil burners
- ☐ Hot water tanks

LABORATORY EQUIPMENT
- ☐ Ovens
- ☐ Cabinets
- ☐ Liquid baths

OTHER (Please fill in your special requirements)

.....

the entire rotor can be adjusted axially by means of an external adjusting screw. Eductor vanes on back of the impeller reduce end thrust, relieve stuffing box pressure, and keep the back of the impeller clean when handling liquids with solids in suspension. Should service requirements change, they can be converted from open to closed impeller or vice versa quickly and easily. The gland face is pre-machined and drilled for easy conversion from conventional packing to mechanical seals. Permanently lubricated bearings are sealed against the entrance of dust and moisture. Parts are standardized so that only two sizes of shafts, shaft locknuts, bearings, bearing cartridges and pedestals are needed for the entire line of seven sizes.

For further information write to De Laval Steam Turbine Co., Trenton 2, N. J., for Bulletin No. 1125.

Pacific Building Boiler Feed Pumps for Utility and Municipal Steam Power Stations

Pacific Pumps, Inc., Huntington Park, California, recently shipped to a leading Mid-West Utility, five boiler feed pumps for installation in one of the most modern steam power stations now being built. Each pump will deliver 800,000 lbs. per hour of 344°F. feed water against 2430 p.s.i. discharge pressure. At the present time, Pacific is building for one Utility, feed pumps for 500,000 lbs. per hour of 330°F. feed water at 1920 p.s.i. discharge pressure and for another Utility, feed pumps to deliver 325,000 lbs. per hour of 300°F. feed water at 1635 p.s.i. discharge pressure. Feed pumps for 465,000 lbs. per hour of 295°F. feed water and 1220 p.s.i. discharge pressure are in course of construction for a leading southern Utility.

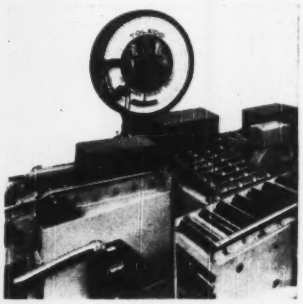
Pacific have finished performance tests of 7-stage Type "ABF" boiler feed pumps for the City of Kansas City, Kansas. Each of these pumps delivers 320,000 lbs. per hour of 233°F. feed water against 1090 p.s.i. discharge pressure.

Other boiler feed pumps in various stages of manufacture for municipal steam plants include main and auxiliary feed pumps for the City of Cleveland, Ohio and main feed pumps for the City of Lafayette, Louisiana. The main feed pumps for the City of Cleveland will deliver 375,000 lbs. per hour and the auxiliary pump 94,500 lbs. per hour. The feed water temperature for both will be 233°F. and the discharge pressure 870 p.s.i. Each of the 8-Stage pumps for the City of Lafayette will deliver 68,500 lbs. per hour of 300°F. feed water against 850 p.s.i. discharge pressure.

Available on request, Pacific's new Bulletin 109 fully describes their boiler feed pumps.

New Toledo Automatically Rejects Off-Weight Containers

A new automatic weight classifying scale for checking cases, cartons and containers is announced by the Toledo Scale Co. This new Toledo, when installed in a conveyor system, will determine if filled containers are within a predetermined weight tolerance. It will also determine if a case contains the proper number of units, and whether each unit in the case is full measure.



It is designed to check-weigh and classify cartons of such items as paper products, chemicals, foods, cigarettes, bottled or canned liquids, assembled parts, etc.

The scale is equipped with adjustable photo-electric controls and will advance "correct-weight" cartons along the conveyor.

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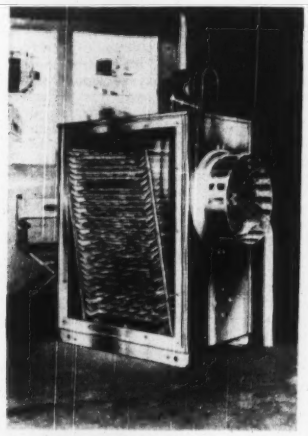
It can be adapted to either automatically reject "off-weight" cartons onto a separate conveyor; or to stop the main conveyor until the case is manually removed from the scale. It can also be made to count the number and print the weight of cartons passing over the scale.

This new device will handle up to 15 containers per minute. It is recommended for items having a gross weight of at least 15 pounds. Capacity of the model illustrated is 75 pounds. The capacity can be increased to several hundred pounds by using a larger scale and a heavy-duty conveyor.

Illustrated here is the new Toledo Automatic Weight Classifying scale with photo electric controls, installed in a conveyor line. The photo shows an "off-weight" carton elevated about to be rejected on the transverse conveyor, to the rejection conveyor.

Aquatowers

Kansas City, Kan.—The Marley Co., Fairfax and Marley Roads, Kansas City, Kan., manufacturers of water cooling towers, nozzles, and DriCoolers, announces that the new 1950 Aquatower line will have an additional size plus improvements on all models.



A 20-ton Aquatower will be available to meet the increasing demand for this size unit. Interiors of all towers will be lined with a thick coating of rubber to make the interior of the tower impervious to corrosion. A new quiet, deep pitch fan is used which operates at one half the usual speed. The rubber lining plus the slow speed fan gives unusually quiet operation.

Aquatowers are a packaged product, completely assembled, ready to go. They are sized from 3 to 50 tons. Aquatowers still have the open distribution basin, redwood filling from top to bottom, totally enclosed motors and complete basin fixtures. They are carried in stock in many principal cities or are available for immediate shipment from any of the four Marley Factories. Request Bulletin AQ-50.

New Oscillograph Features High-Voltage C-R Tube

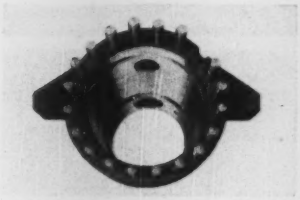
Improved sweep circuit, fast sweep starting time, and high light output characterize the new Du Mont Type 250-AH Cathode-ray Oscillograph.

Recurrent, single, or driven sweep durations are continuously variable from 5 sec-

Continued on Page 48

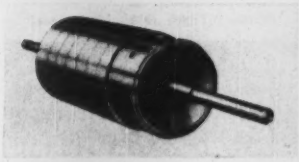
Here's how your high pressure Boiler Feed Pump is Precision Built by Pacific

1 The steel forging for the outer case is thoroughly annealed.

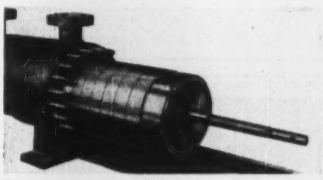


2 The outer case is precision finished.

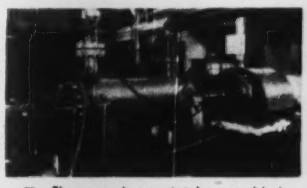
3 The diffusers and impellers are chrome alloy steel—impellers dynamically balanced.



4 The unitized internal assembly is assembled outside the case. All parts are precision finished.

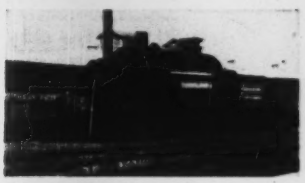


5 The unitized internal assembly is installed in the outer case.



6 The pump is completely assembled—then performance tested.

7 Following test, pump is dismantled; checked; inspected; reassembled.



8 A precision-built, performance-tested, inspected Pacific Pump is on its way!

PACIFIC *Precision Built* PUMPS

Bulletin 109 Gives Details

Pacific Pumps inc.

HUNTINGTON PARK, CALIFORNIA

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SPECIFIED OPERATING RANGE

MERCOID CONTROLS ARE EQUIPPED WITH MERCURY SWITCHES, THEREBY INSURING GREATER SAFETY, BETTER PERFORMANCE AND LONGER CONTROL LIFE

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FOR HANDLING HIGH TEMPERATURE AND HIGHLY VOLATILE LIQUIDS

NEW! WATER JACKETED APCO with EXTRA DEEP STUFFING BOXES

Motor Driven APCO Two Stage, Water Jacketed, Turbine-Type Pump with Flange Connections.

SINGLE AND TWO STAGE
•
1750 R.P.M.
•
WIDE RANGE OF SIZES
•
FOR SCREW OR FLANGE CONNECTIONS

These notable pumps are made available "by request" of many of our engineer friends. Water jacketed APCO pumps were developed specifically for the efficient handling of high temperature and highly volatile liquids. They are designed to compensate for expansion and contraction due to heat. Because Apco's multi-vaned impeller handles vapor or air along with the liquid there can be no vapor lock within the pump. The cool liquid in the water jacket reduces the temperature of any liquid leakage through the extra deep stuffing boxes — thus flashing or vaporizing of the leakage is prevented. May be made of any machinable metal for handling corrosives. Requires but small amount of such special metal — with resultant economy. We invite your consideration of the many features of these fine pumps.

AURORA CENTRIFUGAL PUMPS

A complete line, notable for streamline coordination between impellers and shells, including Single and Two Stage Horizontally Split Case, Side Suction, Vertical, Non Clog, Sump, Mixed Flow, Special Design, etc.

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AURORA PUMP COMPANY
96 Loucks Street, AURORA, ILLINOIS

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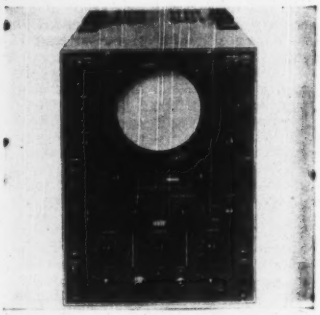
onds to 10 microseconds. The cathode-ray beam rests at the left side of the screen, resulting in negligible sweep starting time on driven sweep. On the return cycle the trace is automatically blanked out. A Z-axis input is provided for intensity modulation.



The Type 250-AH employs a Du Mont Type 5RP-A High Voltage Cathode-ray Tube. The overall accelerating potential for this tube, supplied by an external high-voltage power supply, is 13,500 volts. This high potential makes possible the observation and photographing of high-speed signals recurring either at random or at slow, recurrent intervals.

In the Type 250-AH as in the earlier Du Mont Type 250-H, input signals may be applied (1) through an a-c amplifier, (2) through a d-c amplifier, or (3) directly to the deflection plates for both X- and Y-axes. The frequency response of the d-c amplifiers is uniform within 10% to 200,000 cps, while the response of the a-c amplifiers is uniform within 10% from 5 to 200,000 cps.

The Type 250-A, a low-voltage version of the Type 250-AH, is also available. The Type 250-A employs a Type 5CP-A cathode-ray tube operated at an overall accelerating potential of 3,000 volts.

A built-in square-wave voltage calibrator, accurate to within plus/minus 5%, provides outputs of 0.01, 0.1, 1.0, 10 and 100 volts.

Detailed information on these latest oscillograph models may be had by writing Allen B. Du Mont Laboratories, Inc., Instrument Division, Clifton, N. J.

Man-Made Hurricane Tests New G-E Motor

A stream of freezing water, blasted through the air at more than a mile-a-minute, was used to demonstrate the staying power of a new General Electric motor recently.

At a preview showing of its new modified base-ventilated motor, the company's Small and Medium Motor Divisions staged a man-made hurricane to prove that the new design would withstand the most severe rain and wind conditions and continue to

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operate. A group of visitors from Ebasco Services, Inc., witnessed the demonstration at the G-E Schenectady (N. Y.) Works.

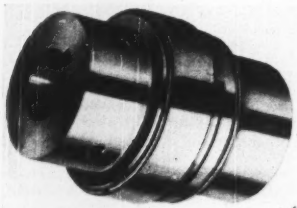
The new motor is designed in large sizes to supplement the company's line of totally-enclosed fan-cooled motors for external applications such as driving power-station auxiliaries installed out-of-doors. In the test, it was mounted on a concrete base raised sufficiently from the ground to allow contaminated ambient air to flow through the foundation at high velocity, as in a storm. The "storm" used in the demonstration was created with the help of a fire hose and a motor-driven airplane propeller. In sub-freezing temperature, the propeller developed an air current in excess of 60 mph, throwing the water, which was shot out of the fire hose under high pressure, against a steel "back board". This "back board" broke up the stream of water into a rain-like spray and directed it at the motor under trial. The freezing particles adhered to the concrete base and the housing and shaft of the motor, but did not hinder its operation in the least, observers said.

After being subjected to this treatment for 30 minutes, the motor was disassembled. Its coils, inner air passages, and bearing housings were completely dry.

New Flexible Coupling Features Introduced by Lovejoy

Extra ease of installation, larger bore capacities, are important features provided by the improved Lovejoy L-R Type "C" and "H" Couplings. These couplings are designed for use on motor-driven or engine-driven pumps, compressors, generators, pulverizers, and almost all machinery of 50 to 1,000 HP. Heavy models are of electric cast steel.

In these new couplings, the inside sleeve is made in two parts, instead of one—providing a sleeve in each body. Both bodies are machined alike for the removal steel collar. This makes it easy to put the collar on either half of the coupling. The collar is held in placed by a snap-ring.



As with all Lovejoy Couplings, these new models instantly adjust for misalignment, shock, vibration, oscillation, surge or backlash. Also, half of the cushions are idlers (except on reversing load); hence there's always a set of new cushions in the coupling. This eliminates shut-downs, as load cushions can be quickly interchanged without tearing down coupling. Cushions are always in sight. There is no wear on the metal jaws, and couplings will last a lifetime. No lubrication is required, and yet all couplings are extremely quiet in operation.

Lovejoy Couplings are available with several types of cushion materials—each adapted to a particular service or kind of service, indoors or out. An example is the Essex "SXB," employing oil-resisting Neoprene protected by bronze. It's designed for use where oils, chemicals, ozone and heat would deteriorate ordinary cushions rapidly.

Continued on Page 50

S.S. White

FLEXIBLE SHAFTS SIMPLIFY DESIGN

. . . for VIBER CO. engineers

In this multiple concrete agitator S.S.White flexible shafts provide a dependable drive for the vibrating heads and at the same time absorb the vibration and prevent it from affecting the rest of the equipment.

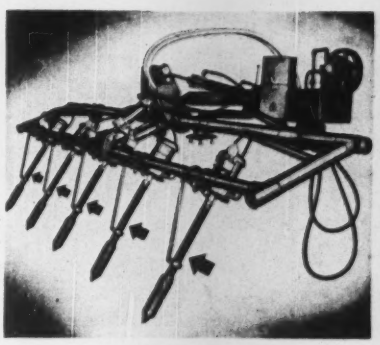


Photo courtesy of Viber Co., Burbank, Calif.

The natural ability of S.S.White flexible shafts to absorb vibration while transmitting power is an important factor to consider when you are designing power drives—particularly where the driving and driven elements are not in alignment. Bear in mind that S.S.White flexible shafts are basic mechanical elements engineered and built specifically for out-of-line driving. For basic data about them—

WRITE FOR BULLETIN 4501

It contains essential facts and data on flexible shaft selection and application. Write for a free copy today.

S.S.White MAKES IT RIGHT

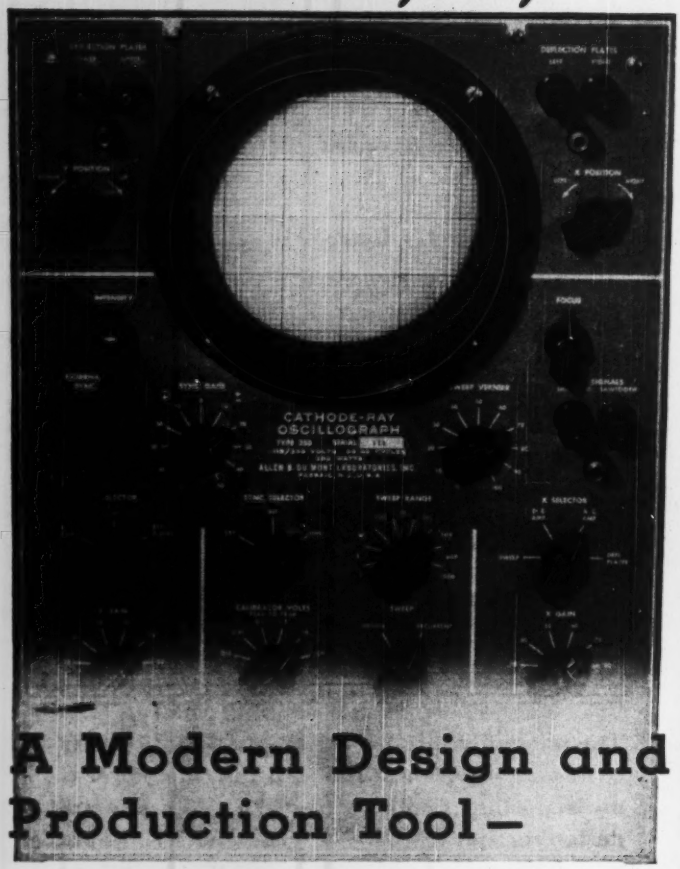
S.S.WHITE INDUSTRIAL DIVISION

THE S. S. WHITE DENTAL MFG. CO. DEPT. L, 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS AND ACCESSORIES
MOLDED PLASTICS PRODUCTS—MOLDED RESISTORS

One of America's AAAA Industrial Enterprises

Worth Investigating . . .



A Modern Design and Production Tool—

Its easy-to-interpret-pattern instantaneously provides a graphic, 2 dimensional description of studied phenomena—yet the cathode-ray oscillograph is as simple to operate as your radio. Learn how its versatility was applied to specific mechanical problems presented to Du Mont engineers. Write for pamphlet DT101.

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Instrument Division, 1000 Main Ave., Clifton, N. J.

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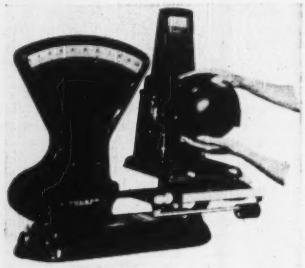
Lovejoy builds couplings for every service and kind of service from 1/6 HP to 2500 HP.

Selector Charts (furnished with the complete catalog) make it easy to find the required coupling without tedious figuring. Further details may be had by addressing Lovejoy Flexible Coupling Co., 5032 W. Lake St., Chicago 44, Ill.

Toledo Announces New Scale for Weighing and Testing Bowling Balls

A new, special weighing device for the weighing and testing of bowling balls, is announced by the Toledo Scale Co.

The scale, developed in cooperation with the Research Department of the American Bowling Congress, provides automatic indication for both the gross weight of the ball and its condition of balance.



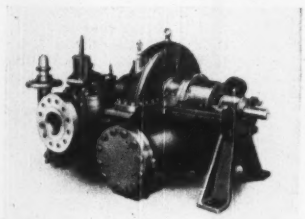
On older-type equipment, it is necessary to check the ball in six different positions. With this new Toledo, both the gross weight and the balance of a ball's six sides (an ABC requirement) can be determined quickly by placing the ball in only three positions.

This feature will enable the manufacturers of bowling balls and the operators of tournament alleys to check balls in less than half the time previously required. This is possible because, with the new Toledo, there are fewer positions to balance and the weight and condition of balance are automatically indicated.

A number of these new scales will be used in the 1950 ABC Championship Tournament held in Columbus, Ohio.

Single-Stage Turbine Designed Especially for High Pressures

Recognizing the trend toward higher and higher pressures and temperatures, the De Laval Steam Turbine Co. announces the first standard single-stage turbine designed especially for high pressure service. Initial pressures to 1450 psig, initial temperatures to 950 Ftt and back pressures to 300 psig.



The De Laval CP Turbine is more than an ordinary single-stage turbine in a "beefed up" high pressure casing. It is the first single-stage, mechanical drive turbine with all labyrinth shaft seals. These seals consist

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of a series of shaft grooves and mating tongues of stainless steel packing. The number of labyrinths in the shaft depends upon the exhaust pressure rating—as many as 52 labyrinths per side being employed for the highest pressures. The De Laval labyrinth seal prevents leakage effectively, reduces losses, lasts longer and requires less maintenance.

To provide for extreme thermal expansion encountered in high temperature service, the turbine is supported at the true centerline and the front end is mounted on a flexible channel. This method of mounting permits both radial and axial expansion to take place without disturbing the shaft centerline.

The turbine can be furnished with any of eight different types of governors including: mechanical shaft, vertical flyweight with or without oil relay, hydraulic with or without oil relay, pressure governors for pump and blower drives and auxillary tripping devices. A separate trip operating independently of the governing system gives positive protection against overspeeding.

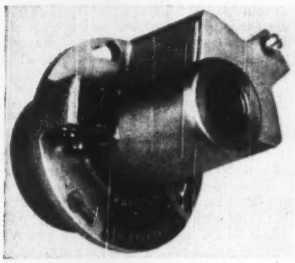
The De Laval CP Turbine is made in three sizes for capacities up to 2000 hp.

For further information write to the De Laval Steam Turbine Co., Trenton 2, N. J. for Bulletin No. 4215.

Rayotubes

New Rayotube Features Quick Sighting; Stability in Drafts and Hot Spots.

Built to work with all Micromax and Speedomax Rayotube instruments, this new Rayotube is an important advance in radiation pyrometry. Present users of Rayotubes, as well as future ones, will find this completely new, advanced design detector unusually easy to apply, especially to such equipment as slab furnaces, soaking pits, open-hearths, ceramic kilns... wherever operating conditions are severe.



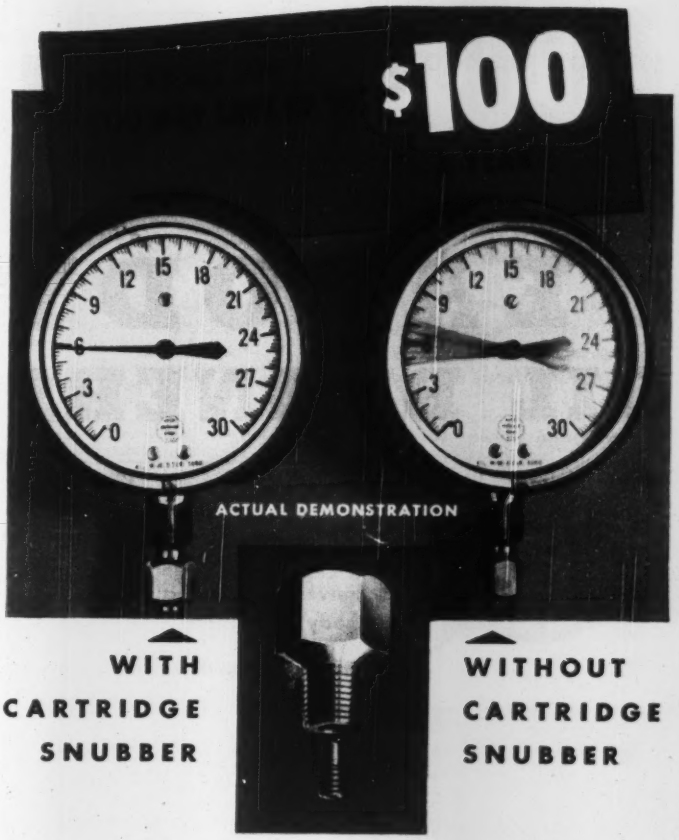
Quick-sighting optical system lets user select desired target easily, and then check the sharply-defined area which the Rayotube sees. Increased sharpness is also of beenfit when radiation comes from end of a closed tube.

Hermetically sealed construction at lens, window, and leadwires keeps out dust and gases. New design guards inherent accuracy and stability, even with high or rapidly changing Rayotube housing temperatures.

Ease of replacement. Purposely designed for easy, low cost replacement, the new Rayotube fits all existing Rayotube mountings. This unit requires no protection against high ambient temperature unless its housing temperature exceeds the very high figure of 350 F. Below that point, any previously installed water- or air-cooling can simply be turned off or disconnected.

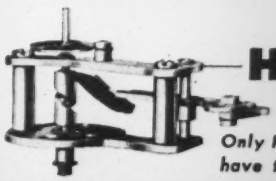
For further information, please write to Leeds & Northrup Co., 4934 Stenton Avenue, Philadelphia 44, Pa.

Continued on Page 52



• Why wreck gages needlessly? When pressure pulsations are so rapid that the gage pointer vibrates excessively, a HELICOID Cartridge Snubber is needed. This is the most simple and effective of all pressure pulsation dampeners. It is threaded into the gage socket for only 54¢. It may save you up to $100.00 a year in gage replacement expense!

For severe pulsation services, order your Helicoid gages with snubber cartridges in the socket. Or, order complete snubbers separately. Specify for water, air or oil; ¼" or ½"; bronze or stainless steel.



HELICOID

ACCO

Only Helicoid Pressure Gages have the Helicoid Movement

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE COMPANY, INC.
Bridgeport 2, Connecticut

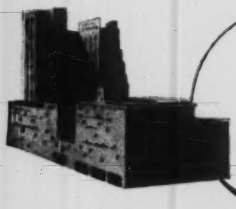
TRADE MARK

SPENDS $82,000 SAVES $94,718

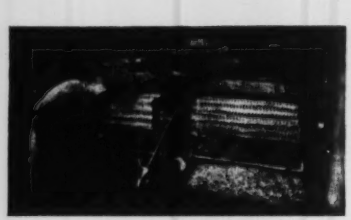
the first year

WITH

PEABODY OIL BURNERS



The Hotel St. George in Brooklyn *saved the cost of the entire installation* in less than one year by converting from coal to Peabody Oil Burners.

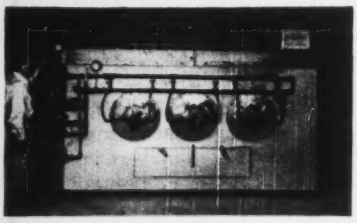


Before . . .

The St. George Hotel used 17,000 tons of bituminous coal a year to fire four 400-HP boilers operated at 75% efficiency. Conversion to oil was based on records dating back to 1928 and included *all* costs of operation.

After

Dirt and dust, along with coal bins and stokers, ash removal problems and maintenance expense, together with high labor costs, have been eliminated by Peabody oil burning equipment that fires these same boilers at 81% efficiency!



PEABODY PRODUCTS INCLUDE: *Automatic Gas and Oil Burners • Pump and Heater Sets • Direct Fired Air Heaters • Gas Scrubbers, Coolers and Absorbers • Burners, singly or in combination, for firing Oil, Pulverized Fuel, and Gas (manufactured, natural, refinery or blast furnace).*

509

OFFICES IN PRINCIPAL CITIES

PEABODY ENGINEERING CORPORATION

580 FIFTH AVENUE • NEW YORK 19, N. Y.

Manufacturers of all types of combustion equipment, direct fired air heaters, gas scrubbers, coolers, and absorbers

• Keep Informed

New X-Ray Thickness Gauge

A new x-ray thickness gauge, designed to measure in steps of 0.0001" cold rolled steel strips ranging in thickness from 0.0050" to 0.1196", is available from Westinghouse Electric Corp.

The gauge compares the amount of x-ray absorption from two x-ray beams identical in intensity, one through a sample of steel of the exact thickness to be rolled, and the other through the steel strip being rolled. The results are interpreted visually.

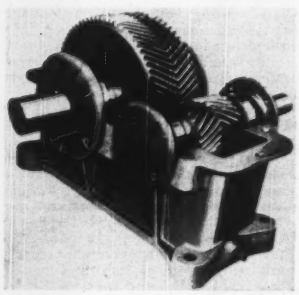
The illustration shows the operator's control. The upper line of controls may be set to operate the tolerance limits indicator lights for high speed mill applications or to operate the reject gate on a classification line. The second line of controls is provided to energize and calibrate the gauge. The third line of controls automatically sets up the sample thickness of steel to be rolled. Thickness of the sample in the standard x-ray beam is shown in the windows above these controls.

Electrical and radiation protection are provided to safeguard personnel. Mechanical protection is provided to minimize the damage to the transformer, x-ray tubes, pick-up unit and sample systems in event of a cobble or a mill wreck. Equipment is sealed to hinder the entry of dust and moisture.

For further information write Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.

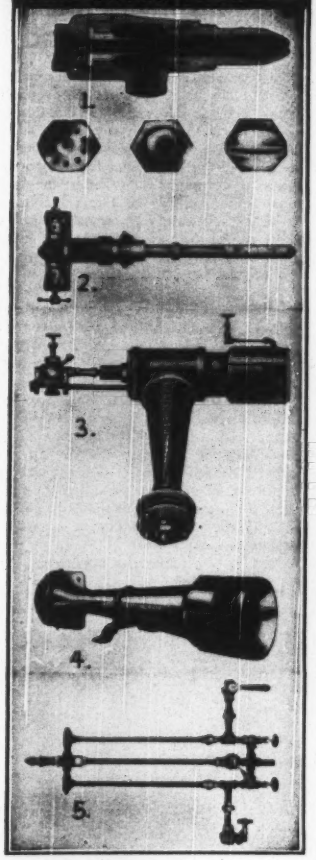
De Laval Announces New Line of Heavy-Duty Herringbone Gear Speed Reducers

The new IMO-De Laval herringbone gear speed reducers are available in single, triple and double reduction units of from $\frac{1}{2}$ to 1000 HP, with center distances from 4" to 36". These reducers are designed to make the most of the inherent reliability and ruggedness of well made herringbone gearing.



All shafts turn on high capacity anti-friction bearings. Output bearings of standard torque units are designed to carry medium overhung loads. Overhung load type units use double-row tapered roller bearings.

THE *RIGHT* OIL BURNER OR GAS BURNER *FOR YOUR JOB*



TYPE "S-A"

1. (For use where steam is available) *atomizes thoroughly* and *burns completely*, the lowest and cheapest grades of fuel oil and tar, requiring only low oil pressure and temperatures. Send for Bulletin #21.

TYPE "S-A-L"

2. (Large capacity burner similar to TYPE "S-A-R") is adaptable in combination with powdered coal burners in large boilers. Send for Bulletin #24.

COMBINATION GAS AND OIL BURNER

3. —the "AIROCOOL" Gas Burner in combination with a TYPE "S-A-R" Oil Burner. Send for "AIROCOOL" Brochure.

"AIROCOOL" GAS BURNER

4. (Of venturi type) assures low turndown without burnback. Send for "AIROCOOL" Brochure.

TYPE "S-A-D"

5. (Refuse Oil Burner) burns acids or caustic oils, sludges, asphalts, tank bottoms, polymer oils, heavy petrolatum, organic oil residuums, waste cutting oils, sulphite pulp liquors, etc. Send for Bulletin #21.

NATIONAL AIROIL BURNER CO., INC.

Main Offices and Factory:
1239 E. SEDGLEY AVE., PHILADELPHIA 34, PA.
Southwestern Division: 2512 South Boulevard
Houston 6, Texas

• Keep Informed

The gears are made of electric steel castings or high carbon steel forgings. Pinions and pinion shafts are cut integrally from heat treated chrome-molybdenum steel.

Because of their exceptionally high efficiency—over 98% in single reductions—IMO-De Laval herringbone speed reducers effect worthwhile savings wherever large amounts of power are transmitted. Conveyors, generators, blowers, pumps, machine tools, cranes, hoists, agitators and thousands of other similar types of equipment can be powered through IMO-De Laval herringbone gear speed reducers.

For additional information, write to Advertising Department, De Laval Steam Turbine Co., Trenton 2, New Jersey.

New Concentric Dial Indicators

Announcement has been made by Taylor Instrument Companies of the development of a new Concentric or Full-Circle Dial Indicator for transmitting, receiving and controlling instruments.

This new Indicator has a unique dial construction which makes instrument mechanism easily accessible for inspection or adjustment by simple rotation of the dial. Large pointer with 270° sweep, together with white numerals on a black background stand out effectively so that they can be read from 50 to 100 feet. The instrument may be used with only low pressure unit or mercury manometer actuation for differential or absolute pressure applications. It is available as a simple indicator, indicating receiver, indicating controller, indicating transmitter, indicating transmitter controller or indicating receiving controller. Standard ranges are 0 to 10 on square root scale and 0 to 100 and 0 to 200 on uniform scales.

For further information, write Taylor Instrument Companies, Rochester 1, New York.

New Leeds & Northrup Moistureproof Glass Electrodes

A new series of moistureproof glass electrodes has been developed for Leeds & Northrup pH electrode assemblies of the pyrex glass and enameled cast iron types.

To assure high insulation and low electrical leakage, electrode leadwires are permanently attached . . . molded into the plastic electrode head. Thus, the electrode maintains its fine accuracy even under conditions of high atmospheric humidity.

New pH-responsive glasses offer such outstanding benefits as: fast response, valuable on automatic control applications; low

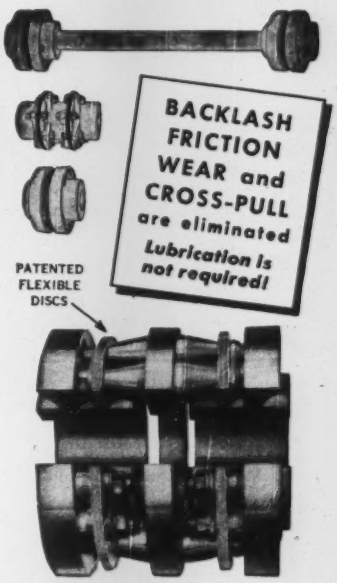
Continued on Page 54

THOMAS *Flexible* ALL METAL COUPLINGS
FOR POWER TRANSMISSION REQUIRE NO MAINTENANCE

Patented Flexible Disc Rings of special steel transmit the power and provide for misalignment and end float.

Thomas Couplings have a wide range of speeds, horsepower and shaft sizes:
½ to 40,000 HP
1 to 30,000 RPM

Specialists on Couplings for more than 30 years



THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT.

NO MAINTENANCE PROBLEMS.

ALL PARTS ARE SOLIDLY BOLTED TOGETHER.

Write for the latest reprint of our Engineering Catalog.

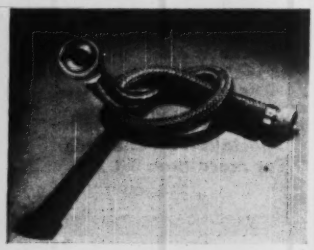
THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

resistance, for accuracy at low temperature and for minimizing insulation problems; and sodium error so low that the same electrode can be used for any range of acidity or alkalinity.

Electrodes are color-coded for three ranges of solution temperature: 0 to 30 C; 20 to 60 C; and 50 to 90 C.

Flexible Stainless Hose Now Available in Full Range of Sizes and Wall Thicknesses

Corrosion resistant flexible stainless steel hose is manufactured by Chicago Metal Hose Corp. in several types. This hose, able to withstand high temperatures and pressures, is used for conveying corrosive or searching liquids and gases where motion is required.

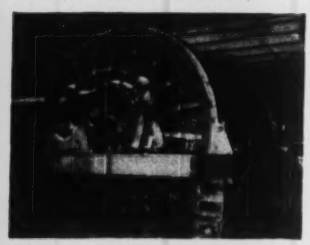


Extreme flexibility gives hose the ability to withstand extreme cycles of vibration, flexation and variplane motions. For constant flexing or continuing motion, a hose with closed corrugation pitch, is recommended; for infrequent flexing, misalignment or slight movement an open corrugation pitch hose is recommended.

This stainless steel hose is fabricated in sizes from $^{3}/_{16}$" through 6" I.D. in one or multiple ply construction. Available with helical or annular corrugations, with or without braid covering, depending upon pressure and other factors of service use. Wall thicknesses from .003" in single ply to 0.30" in multiple ply construction; working pressures to 2000 p.s.i. Standard pipe fittings or fittings to special requirement may be attached by silver brazing or welding. For further information write Chicago Metal Hose Corp., 1305 South Third Ave., Maywood, Ill.

G. E. to Supply Electric Drive and Control Equipment for West Coast's First Semi-Continuous Hot Strip Steel Mill

More than $2,500,000 worth of electric drive and control equipment is now being built by General Electric for the West Coast's first wide semi-continuous hot strip steel mill, it was announced recently.



The new mill will be added to an existing roughing mill at the Kaiser plate mill in Fontana, Calif., which will break down steel slabs for finishing on the new hot strip mill. This 86-inch-wide strip mill will be capable of rolling sheet steel at the rate of 2,000 fpm.

Power to drive the huge mill will be supplied by one 3,500-hp and three 5,000-hp G-E motors. The company will also furnish auxiliary motors, control equipment, switchgear, transformers, and ventilating equipment.

According to G-E engineers, this will be the first hot strip steel mill in the country to use rectifiers alone for converting the alternating current supplied to the mill to the direct current required by the huge drive motors. Previously, mills of this type used separate motors and generators for the conversion.

When the new Kaiser mill is completed, it will be used to produce steel for welded pipe and for other products requiring heavy gage sheet steel.

General Electric Develops Portable Device for Low-Temperature Testing of Ball-Bearing Lubricants

A compact, semi-portable device for low-temperature testing of ball-bearing lubricants has been developed in the General Electric Company's Schenectady Works Laboratory.

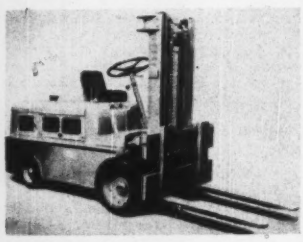
Lubricants for ball bearings in such applications as aircraft gun turrets must be effective at temperatures as low as 65 degrees below zero, G-E engineers explained. The new laboratory device simplifies testing problems since it eliminates the need for elaborate cold rooms, they said.

Heart of the device is a cooling chamber, which resembles a large bucket with a smaller bucket inside it both covered by a transparent plastic lid. Dry ice is placed in the space between the inner and outer buckets.

In testing, a ball bearing is placed on a spindle in the inner bucket and rotated by a small electric motor. The tendency of the outer ring of the ball bearing to move with the inner ring is measured by a strain gage. If a lubricant under test thickens in the cold atmosphere, the inner ring will not turn freely, and the gage will register a greater strain on the outer ring.

10,000-Pound Fork Truck With Dynatork Drive Announced by Clark

A 10,000-pound capacity fork-lift truck, gasoline powered and equipped with the Dynatork Drive, has been added to its expanding line by the Industrial Truck Division of Clark Equipment Co. The new model is known as the Utilitruc-100.



The Dynatork Drive, pioneered by Clark, will be standard equipment on the new truck, and the only type of drive available. It transmits engine power through a magnetic field, across an air gap, eliminating need for any type of friction clutch. The conventional transmission is also eliminated, and replaced by constant-mesh forward-and-reverse gearing.

Advantages resulting from the Dynatork Drive, according to Clark Engineers, are

design

MAKES ALL THE DIFFERENCE IN WELDING TEES, TOO

When seamless drawn welding tees were introduced some 17 years ago, they represented a great advance over cut-and-welded intersections. Even so, they still had certain inherent weaknesses. Their design was unstable under high internal pressure and bulging resulted at the flat spots of the side walls. The relatively weak crotch area, carrying an unequal share of the load, usually gave way first in bursting tests. To compensate, tees were made excessively heavy.

Tube Turns research engineers developed a new welding tee design based on the sphere, nature's strongest form for resistance to internal pressure. This shape, with necessary modifications, became the basis for an entirely new welding tee design.

In the Tube-Turn barrel-type tee, the internal pressure load is carried largely in direct tension. And, in bursting tests involving the old and new design, it proved capable of withstanding 22% more pressure before yielding. It is at least 25% stronger than the code (ASA B16.9) requires, as evidenced by these test results on 6" tees:

	BURSTING PRESSURE	
Schedule	ASA B16.9 Required	Test Minimum
40	4440 psi	5950 psi
80	6845 psi	8625 psi

Result of typical hydrostatic bursting test conducted in the Tube Turns research laboratory. The pipe itself split wide open under the terrific pressure applied; the new Tube-Turn welding tee is undamaged. Micrometer checks reveal no evidence of yielding or distortion.

FREE BOOKLET

Write for your free copy of "Research", a booklet reporting results of cyclic tests being conducted by Tube Turns engineers on the fatigue life of piping assemblies. Well illustrated. Contains valuable information on relative fatigue life of welding elbows, mitre bends, various types of flanges.

"Be Sure You See The Double tt"

TUBE TURNS, INC.

LOUISVILLE 1, KENTUCKY

TUBE-TURN

In all the world there's only one TUBE-TURN Welding Fitting as shown by this trade mark... the right mark for every need in welding fittings and flanges.

Your nearby TUBE TURNS distributor can serve you right from stock. Call him for prompt delivery

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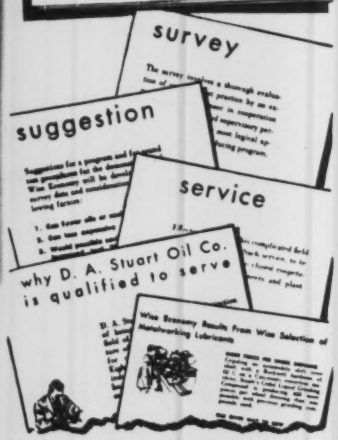
HERE IS THE WAY TO LOWER MACHINING COSTS



NOT just another spot check "oil survey", the Stuart plan is a scientific appraisal of a plant's over-all cutting fluid needs. Ask for details.

D.A. Stuart Oil co.
2741 S. Troy St., Chicago 23, Ill.

• Keep Informed . . .

increased work-capacity for the machine, higher efficiency, greatly reduced maintenance, minimum driver fatigue and improved all-around performance.

Other noteworthy features are the Clark pivoted steering-axle assembly, which increases stability by maintaining all four wheels in constant contact with the road surface; and a 6-cylinder Red Seal Continental industrial-type engine of 209 cubic inch displacement, developing 50 brake horsepower at 1800 rpm.

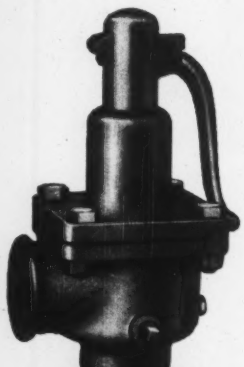
Specifications of the machine include: overall length, 107 inches; wheelbase, 66 inches; overall width, 50½ inches; outside turning radius only 104 inches; and inside turning radius, 12 inches. The machine turns readily in intersecting aisles of 88-inch width.

Easy steering, maximum driver comfort and visibility, unusual maneuverability and ease of operation and elimination of stresses and strains characteristic of rigid frame-mounting are other advantages claimed for the new machine. The forward-and-reverse control lever is mounted on the steering column, and response is instantaneous. An "inching" pedal is located in the position normally occupied by the conventional clutch pedal. A single gear shift lever controls low and high speeds. In the main, the driving operation is similar to driving an automobile.

Development of the Utilitruc-100 came in response to a widespread demand by many industries for a compact, highly maneuverable machine of this capacity. The new model is not available for export sale. Additional information is available upon request to the Clark Equipment Co., Industrial Truck Div., Battle Creek, Mich.

Safety and Relief Valves

A complete line of cast carbon and alloy-steel safety and relief valves has been added to the bronze line which Kunkle Valve Co. has manufactured since 1875, according to Louis Fox, president and general manager of the company.



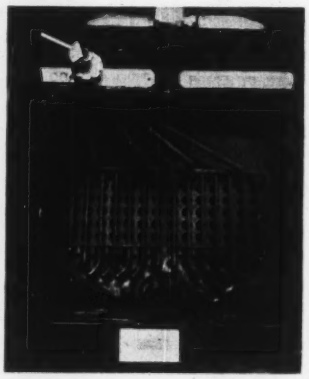
The new constructions include all types formerly manufactured by Star Brass Co. whose facilities have been purchased by Kunkle.

A typical valve, Figure 73, illustrated above, is cast carbon steel with stainless steel trim for pressures to 600 lbs., temperatures to 650°F., sizes ¾ to 6 inches; A.S.A. Standard flanged inlet and flanged or screwed outlet. N.B. Certified A.S.M.E. Tested. The valve is a Navy approved adaptation with high discharge capacity and close blow-down control, according to the manufacturer.

Other valves for air, steam, gases, vapors and liquids in a wide range of pressures and temperature applications are described in a catalog available on request from Kunkle Valve Co., 115 So. Clinton Street, Fort Wayne 2, Indiana.

Hahn Mechanical Soot Blower

The Hahn-Pitz Corp., 286 Scholes St., Brooklyn 6, N. Y. has taken over the manufacture of the Hahn Mechanical Soot Blower which is now being used in industrial plants throughout the country for the removal of soot and fly-ash from the tubes of fire-tube boilers.



Inasmuch as soot-coated tubes prevent the transmitting of the heat of the gases to the water in the boiler, much heat units are carried off by the stack which constitutes the most obvious waste in the operation of the boiler.

The Unit consists of a specially designed quick acting four-way valve controlling the entrance of the steam into the four divisions of the rigidly constructed pipe frame. Individual nozzles set before each tube directs the expanding steam producing thorough cleaning action. Entire operation is completed in one and a half minutes.

It is a proven soot blower, guaranteed to keep each and every tube clean without hand cleaning, thus affording maximum efficiency and greater overloads. Many plants now using hand steam lances are not obtaining a satisfactory job due to infrequent hand cleaning in this manner, the heating surfaces usually accumulates an excessive deposit of soot and the overload operating is very low except for a day or so just after the cleaning. Savings to be obtained from the use of the Hahn Soot Blower will pay for the cost in a short period of time.

Carrier Reciprocating Compressors

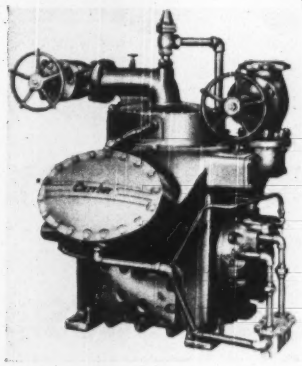
Syracuse, N.Y.—Two new models of large reciprocating compressors—developed to meet commercial air conditioning and refrigeration application needs from 100 to 150 horsepower in single units and designed to operate with a variety of refrigerants—are announced by Carrier Corp., Syracuse, N.Y.

The flexibility of these two new machines marks a new era in Carrier's half-century of experience in development and production of reciprocating compressors and condensing units for air conditioning and refrigeration duty.

• Keep Informed

They can be used either direct or belt driven, powered by motor, gas or Diesel engine, or steam turbine with gear and can be adapted for operation as dual units from a single motor with a double shaft.

The high partial load efficiency of these new machines is due to the latest design in cylinder unloading which also provides unloaded starting so that normal torque motors may be used.



They can be operated on Freon 12, Freon 22 and ammonia.

The Model 5J40, a four-cylinder machine, using Freon 12, has a nominal cooling capacity of 100 tons for air conditioning and 75 tons for refrigeration, or using ammonia, for refrigeration duty, 60 tons.

The Model 5J60, a six-cylinder compressor, using Freon 12, has a capacity of 150 tons for air conditioning and 100 tons for refrigeration, or, using ammonia for refrigeration duty, 90 tons.

Designed for compactness, the new compressors may be mounted on upper floors without massive foundations, as weight and vibration are greatly minimized. All cylinders are located above the center line of the crank shaft for best operating characteristics. Each cylinder is equipped with removable and interchangeable cylinder sleeves with parts accessible for inspection. Lubrication is by positive pressure to all bearing surfaces. Speeds of 900 maximum for Freon 12, and 720 for ammonia, are higher than in old type machinery but are based on conservative coefficients of bearing pressure and friction.

The two machines have identical bores and strokes, and the cylinder sleeves, valves, and other operating parts are interchangeable, so that service is greatly simplified and reduced in cost.

Silver Plating Aids Jet-Engine Bearings

Silver and tin, two metals far apart in value, are working closely and effectively in solving lubrication and corrosion problems of high-speed aircraft engines.

The metals are used as thin deposits on precision aircraft bearings produced by SKF Industries, Inc., for jet and piston-type engines. Plating the bronze retainers of roller bearings with silver, explains F. W. Wellons, head of the firm's aircraft division, lessens the chances of one metal's "seizing" another when operating under extremes of speeds and temperatures such as those encountered in jet planes. That is because the silver, one one-thousandth of an inch thick, acts as a "dry" lubricant. These retainers are in

Continued on Page 58

WHICH DUST PROBLEM can you turn into PROFIT with PANGBORN DUST CONTROL?

VALUABLE DUST . . .

Some dusts are valuable! Dust from packing, transporting or processing raw materials or products can be *salvaged at a profit* by Pangborn Dust Control. For instance, one of America's largest chemical plants reports that on a yearly basis, their Pangborn Dust Control system recovers *$14,859 worth* of valuable chemicals!

HAZARDOUS DUST . . .

Dust can be extremely dangerous! In certain concentrations, dust is actually more explosive than gasoline. With Pangborn Dust Control you can reduce explosive dust hazards, earn lower insurance rates, run less risk of damage to your plant. In the coal field alone, scores of processors rely on Pangborn Dust Control to protect their property!

BOTHERSOME DUST . . .

Dust costs you money! Dust makes walls dirty, gets into bearings and machinery, sends maintenance costs sky high! But with Pangborn Dust Control, housekeeping problems are solved *at a profit*. One well-known rubber company recently said: "We save over $1200 a year with Pangborn Dust Control, even though dust has *no salvage value!*"

Look to Pangborn for the latest developments in Dust Control and Blast Cleaning. For full data on Pangborn Dust Control for your plant, write for Bulletin 909-A. Address: PANGBORN CORPORATION, 289 Pangborn Blvd., Hagerstown, Maryland.

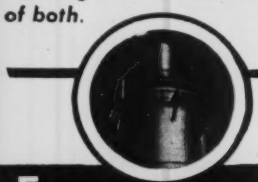
STOP THE DUST HOG from stealing profits with Pangborn DUST CONTROL

If your plant requires

- DIRECT HEATING OF VAPORS
- DIRECT HEATING OF LIQUIDS
- DOWTHERM INDIRECT HEATING
- STEAM GENERATORS
- STEAM SUPERHEATERS
- WASTE HEAT BOILERS

place the selection of the specific type in specialized hands . . . and obtain optimum efficiency.

Petro-Chem Development Company engineers are heating specialists . . . they can supply the whys and wherefores of indirect versus direct heating and the economics of both.



Every day more than 600, oil and gas fired, Petro-Chem Iso-Flow* installations in the petroleum, chemical and allied industries, demonstrate the efficiency of their design and installation.

*Patents issued and pending

PETRO-CHEM DEVELOPMENT CO., INC.
120 East 41st Street, New York 17, N. Y.

Representatives:
Bethlehem Supply, Tulsa and Houston • Flagg, Brackett & Durgin, Boston • D. D. Foster, Pittsburgh • Faville-Levally, Chicago • Lester Oberholt, Calif.

• Keep Informed

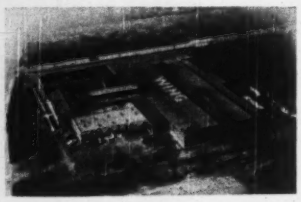
bearings that support the jet's main turbine shaft. The silver coating is 99.99 fine—far purer than sterling.

The races and rollers of such bearings in piston-type engines are tin plated to prevent water from rusting the highly polished precision parts. The tin coating is even thinner—three one-hundred-thousandths of an inch.

• *BUSINESS CHANGES*

Wing Consolidates Factories and Offices

L. J. Wing Mfg. Co., manufacturers of heating, ventilating and combustion equipment and steam turbines, with three separate factories in Newark, N. J., and with general offices in New York City, have consolidated all of these in a single modern factory building at Linden, N. J.



While much needed additional facilities will be provided, including extra land for future growth, the consolidation's principal purpose is to effect closer and more efficient interdepartmental co-operation.

The new address is Vreeland Mills Road, Linden, New Jersey, the telephone number being LInden 2-7400.

An office at 154 West 14th Street, New York 11, N. Y., will be maintained to handle New York City sales.

Wing products comprise unit heaters, steam or gas types, with motor or turbine drives, and with fixed or revolving discharge outlets; process heater sections; forced and induced draft fans and blowers; auxiliary steam turbines; elbow and straight line duct fans; ventilating fans for industrial and marine applications; and industrial fog eliminators.

Kinney Announces New Address For Its Chicago Office

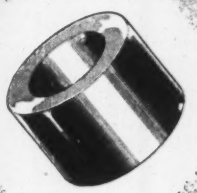
Kinney Manufacturing Co., Boston, Mass., manufacturers of Rotary Liquid Pumps, High Vacuum Pumps and Bituminous Distributors, has moved its Chicago Branch Office from the Socony-Vacuum Building, 59 East Van Buren Street, to Room 1313, People's Gas Building, 122 South Michigan Avenue, Chicago. The Branch Office continues in charge of Alfred J. Munday who has been with Kinney Manufacturing Co. since 1917.

Pacific Centrifugal Pumps Now Manufactured In France

Pacific Pumps, Inc. of Huntington Park, Calif., has completed arrangements with Compagnie Generale De Construction De Locomotives—Batignolles Chatillon, for the manufacture and sale of Pacific Centrifugal Pumps in France. Batignolles will manufacture various types of Pacific Pumps in their Nantes, France Plant, from designs and patterns furnished by Pacific. The Pumps will be marketed throughout the Republic of France, the Territories of Union Francoix and The Saar Territory, under the trade name "Pacific-Batignolles".

The key personnel from the engineering

WORKS WHERE OTHERS WON'T



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SELF-LUBRICATING ○ EXTREMELY DURABLE ○ CONSTANT CO-EFFICIENT OF FRICTION ○ OPERATES DRY — OR *SUBMERGED IN WATER, GASOLINE OR CORROSIVE LIQUIDS* ○ APPLICABLE OVER A WIDE TEMPERATURE RANGE — *even where oil solidifies or carbonizes* ○ EXCELLENT AS A CURRENT-CARRYING BEARING.

GRAPHITE METALLIZING CORPORATION
1058 NEPPERHAN AVENUE, YONKERS 3, NEW YORK

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and manufacturing divisions of Batignolles are spending several weeks at Huntington Park to study Pacific's methods of manufacture. This will insure the maintenance by Batignolles of Pacific's high standards of materials and workmanship, as well as insure interchangeability of parts for pumps manufactured in France and the U.S.A.

• LATEST CATALOGS

New Catalog Describes Radiographic Materials

A new, 16-page catalog of materials for industrial radiography, published by the Eastman Kodak Co., describes films for use with x-ray equipment of varying kilovoltage and with specimens of varying thickness and density. Information on relative speeds and contrast of different x-ray film emulsions is provided in a handy chart to enable the radiographer to quickly select the particular material best suited to his needs.

Additional information is provided on the use of intensifying screens. The catalog is available without charge from the X-Ray Division, Eastman Kodak Co., 343 State Street, Rochester 4, New York.

Heat Exchanger and Condenser Tubes

The Babcock & Wilcox Tube Co. announces a new illustrated bulletin on heat exchanger and condenser tubes. It concerns the economical choice of appropriate tubing for specific service conditions in heat transfer units and for easy fabrication in heat exchanger apparatus. B & W engineering and manufacturing experience is offered to help solve such problems as resistance to corrosion, resistance to oxidation, strength at high temperatures and low temperatures, as well as fabrication problems of bending, expanding and beading which specify uniform quality, size tolerances and mechanical properties.

Specifications and data are offered in a table on carbon, low chromium, intermediate chromium, nickel and stainless steels.

Bulletin TB-329 is available free on request to The Babcock & Wilcox Tube Co., Beaver Falls, Pa.

Ledeen Cylinders

A 12-page catalog, Bulletin No. 500, is announced by Ledeen Manufacturing Co., Los Angeles, manufacturers of pneumatic and hydraulic actuating cylinders. This Bulletin gives dimensions and weights, ratings and limitations of the recently announced Medium Duty line of cylinders, as well as the same information for the Ledeen Heavy Duty and Super Duty lines.

Information affecting the selection of cylinders is included, along with illustrations and designs of rod and head attachments. Bulletin No. 500 describes completely the three lines of cylinders, rod and head attachments which are available from stock through distributors in major cities.

For copies of Bulletin No. 500, write to Ledeen Manufacturing Co., 1600 So. San Pedro St., Los Angeles 15, Calif., or to this publication.

G. E. Announces New Motor Bulletin

A new eight-page, two-color bulletin on Tri-Clad high-speed synchronous motors has been announced as available from the General Electric Company, Schenectady 5, N.Y.

Designated as publication GEA-5426, it lists some of the applications for these motors, such as driving pumps, grinders, compressors, saws, beaters, fans, generators, conveyors, mixers, etc. Profusely illustrated, the bulletin gives three typical instal-

Continued on Page 61

BY means of a simple, reliable stroke regulating mechanism which utilizes a conventional fixed-throw, solid forged steel crankshaft—the Aldrich-Groff "POWR-SAVR" Pump controls delivery in stepless, straight line variation from zero to 100% rated capacity *at constant pump speed.* An automatic monitor, this pump supplies *only that delivery actually needed.* Power consumption is in almost direct proportion to demand.

Built for long-term, low maintenance service *in the power field, for boiler or desuperheater feed,* the Aldrich-Groff Controllable Capacity "POWR-SAVR" Pump offers highest possible volumetric and mechanical efficiencies. Units are built in six sizes, ranging from 2 to 6 inches in stroke and from 5 to 125 bhp. Over 500 units, many with 10 year service records, are successfully operating today.

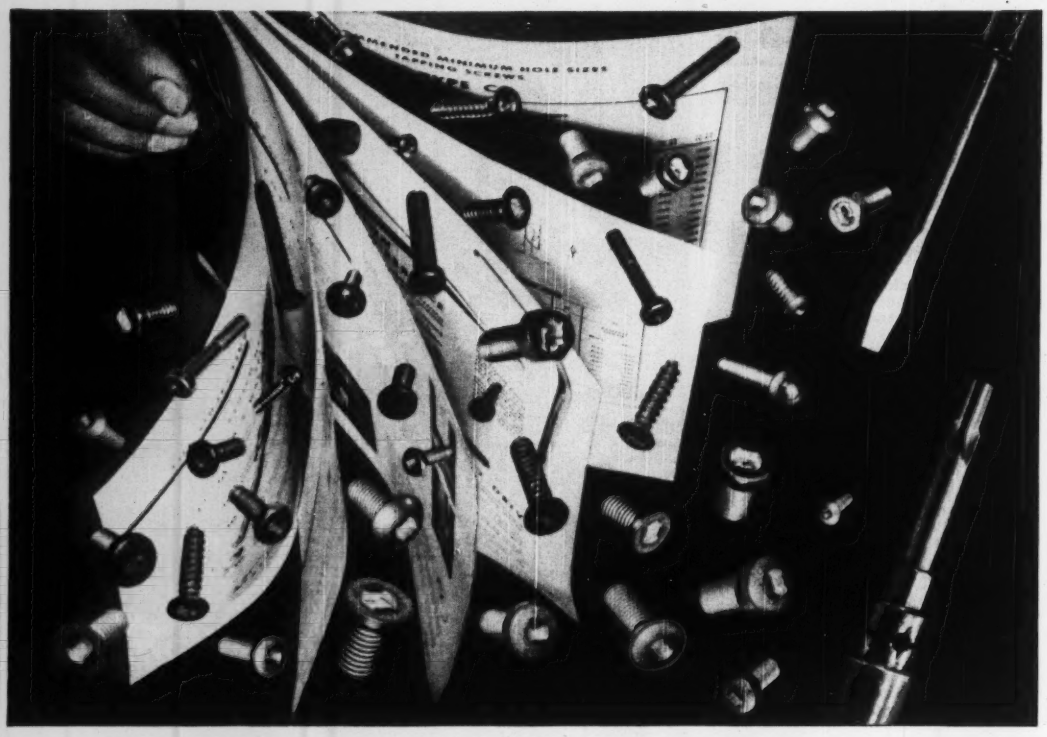
Send for Data Sheet 65 for full details on how the Aldrich-Groff "POWR-SAVR" Pump can give you improved efficiency, simplified and reliable control of delivery, and lower operating costs. Write, without obligation, to:

Representatives: Birmingham • Bolivar, N.Y. • Boston • Buffalo • Chicago • Cincinnati Cleveland • Denver • Detroit • Duluth • Houston • Jacksonville • Los Angeles New York • Omaha • Philadelphia • Pittsburgh • Portland, Ore. • Richmond, Va. St. Louis • San Francisco • Seattle • Spokane, Wash. • Syracuse • Tulsa

THE ALDRICH PUMP COMPANY

29 PINE STREET, ALLENTOWN, PENNSYLVANIA

All Aldrich Pumps Have STAYING POWER



Assembly Costs Take a Tumble with Change-over to CLUTCH HEADS

Users Certify 15% to 50% Production Increases for Lower Final Costs

In view of this testimony you may confidently expect these exclusive time and cost-saving CLUTCH HEAD features to deliver a similar ratio of production increases on your assembly line . . . to lower your final costs by producing more for less.

Higher Visibility of the clutch recess eliminates operator hesitation. Even "green" help drives with speed and confidence. No "break-in" needed.

No Damaged Heads . . . Dead-center entry with the Center Pivot Column prevents driver canting, makes straight driving automatic, and checks out delay and expense fixing burred or chewed-up heads.

Now, Non-Tapered Driving that sends skid damage to zero; safeguarding manpower and material. With CLUTCH HEAD'S all-square driving engagement there is no need for end pressure to combat "ride-out" (as set up by tapered driving) and the drive home is effortless. This safety factor and elimination of fatigue steps up production.

One-Handed Reaching at "Bottlenecks." Only CLUTCH HEAD provides a frictional Lock-On that joins screw and bit as a unit to permit one-handed reaching into inner spots and driving from any angle.

214,000 Screws Driven Non-Stop. This is the record established by the rugged Type "A" Assembly Bit . . . continuous high torque driving on a main assembly line of one of America's largest automotive plants.

New Bit Life in 60 Seconds. Consider the added tool economy of simplified reconditioning this bit REPEATEDLY . . . by a 60-second application of the end surface to a grinding wheel.

Curing Field Service "Headaches." For simplified field service, CLUTCH HEAD alone has a recess that is basically designed for operation with a common screwdriver or with any flat blade which need only be reasonably accurate in width.

These advantages are fully detailed in the New CLUTCH HEAD Brochure . . . along with technical information your engineers and plant executives will want for reference. Start your investigation of CLUTCH HEAD'S potential savings for your assembly by sending for a copy . . . and indicate sizes and types of screws which interest you.

UNITED SCREW AND BOLT CORPORATION

CLEVELAND 2 CHICAGO 8 NEW YORK 7

• Keep Informed . . .

lation stories, describes Tri-Clad protection, and discusses construction features, mechanical modifications, and direct-connected exciters for the motors. Covered are Type TS (3 phase) and Type QS (2 phase) motors in ratings from 20 to 1500 hp at 60 cycle speeds of 1800 rpm, as well as proportional hp ratings for speeds through 514 rpm.

Hydraulic Actuating Cylinders

A technical information bulletin CS 248, describing the use of hydraulic actuating cylinders for the removal of mold cores from fresh concrete pipe during production, is announced by Ledeen Mfg. Co., Los Angeles.

The difficult core removal, and the time saving solution using Ledeen Heavy Duty Cylinders is described, along with cylinder and pressure information. This application suggests the use of hydraulic or pneumatic cylinders for other straight line motion problems.

Copies of Bulletin CS 248 may be obtained from Ledeen Mfg. Co., 1600 S. San Pedro St., Los Angeles 15, Calif., or through this magazine.

Blueprint Marking Pencil

New Brilliant colors in the "Venus" Color Pencil line for marking on blue or white prints. 54% Stronger—sharpens to a sharp needle point and holds it. 27% Greater Markability—brilliant clear marking—waterproof, too! Write for samples "Venus" Blueprint Pencil—American Lead Pencil Co., Hoboken, N. J., Dept. CE 50.

Chelseas' New Catalog and Engineering Data Book

New "Chelsea" illustrated catalog giving full engineering information, dimensions, performance and prices regarding all types and sizes of fans for industrial, commercial and residential applications. This catalog which has just been received from the printers includes many new types of fans with full details as to their application. Included is information on direct drive or belt driven window fans, industrial pressure fans, mancoolers, PH units, duct booster fans and various fans of all kinds and description. Also a full line of automatic counter balanced shutters for all applications. One of the most complete and easy to understand catalogs available on this subject.

These catalogs are available without charge from Chelsea Fan & Blower Co., Inc., 1206 Grove Street, Irvington, N. J.

Air delivery ratings of all Chelsea Products are determined by the Standard Test Code of the Propeller Fan Manufacturers' Association and the American Society of Heating and Ventilating.

New Kelloggram Reviews Accomplishments of East Chicago Refinery Modernization

How Kellogg modernized the Cities Service East Chicago oil refinery and what it all accomplished are discussed and illustrated in detail in "Kelloggram" No. 1, 1950, recently published by The M. W. Kellogg Co., refinery and chemical engineers of Jersey City, N. J.

The issue not only shows the plant as it stands today, still on stream without a turnaround since it was started up in April 1949, but it also includes a score or more of photos taken during the construction phase.

It tells how Kellogg's and Cities' engineers took the pre-war plant in East Chicago and, using much of the existing equipment, but adding new units where necessary, came up with a fully integrated modern refinery in a little less than two years at a cost of about $20,000,000.

The job embraced the engineering and construction of two major units—one for Fluid Catalytic Cracking and one for Delayed Coking—the building of a Light Ends Fractionation Unit and the revamping and expanding of several other portions of the existing refinery.

According to the "Kelloggram," the main accomplishment of the work, aside from the actual value of modernization, is the extreme flexibility of the new refinery. Not only can the quality of the gasoline be varied to meet market conditions, but by-products can also be changed.

For example, the article points out, the coker normally produces premium grade coke for which the present market is relatively good. However, should this market turn "soft," the coker can be adjusted to the production of heavy fuel oil if this is desirable from an economic standpoint.

Highly important also, according to the "Kelloggram," is the fact that the revamping of the boiler house and water treating units, as well as the enlargement of the cooling water supply and waste disposal systems, provide sufficient capacity for a sizable increase in the crude throughput of the refinery. The addition of another "Cat" Cracker and extra drums on the coker would not strain the available utility capacity.

Low-Speed Synchronous Motor Bulletin Announced by G.E.

A new eight-page, two-color bulletin on low-speed synchronous motors has been announced as available from the General Electric Co., Schenectady 5, N. Y.

Designated as publication GEA-5332, it illustrates typical installations of these efficient, high-power-factor, constant-speed drives, describes their construction features, and indicates mechanical modifications and performance data. Covered are Type TS (3 phase) and Type QS (2 phase) motors in the "6000 series" with frame sizes of 6184 and larger, and ratings from 20 to 15,000 hp.

Pencil Sketching Booklet!

Twenty-four pages of helpful illustrated instructions on pencil sketching. Only 25¢ with two Free "Venus" Drawing Pencils—American Lead Pencil Co., Hoboken, N. J., Dept. CE 50.

New Edition of Silent Sentinels Published

A newly-revised edition of Silent Sentinels, a 236-page reference book devoted to protective relays, has been published by the Westinghouse Electric Corp. The first to be issued since 1940, this latest edition records the growth of the relay art to date, including the most recent developments in the design and application of protective relays and relaying systems.

The book is divided into two parts; the first dealing with the application of protective relays, and the second with the equipment itself.

Subdivided into eleven chapters, Part I discusses relays and circuit breakers, faults on power systems, and calculation of short-circuit currents and voltages in the first three chapters. Chapters 4 through 7 deal with vectors for relay systems, protection of a-c apparatus, protection of station buses, and protection of transmission circuits. The remaining chapters of Part I treat pilot relaying by wire and carrier, protection of multi-terminal lines, d-c system protection, and miscellaneous relay applications.

Part 2, consisting of eight chapters, presents detailed descriptions of the various types of Westinghouse protective relays. The construction and operation of each type

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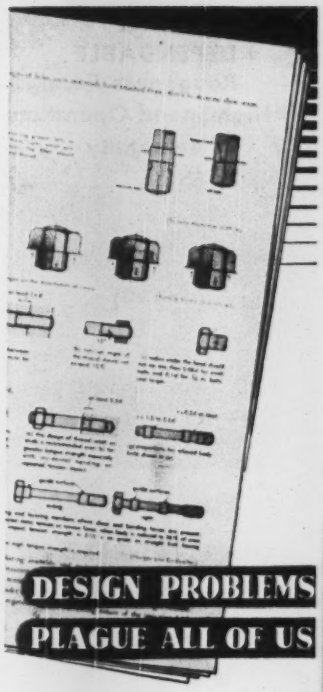

To serve well, a machine part—even when made of good steel, properly treated—must be properly designed.

A new 72 page booklet, sent free on request, discusses the vital relation between design, good steel and its satisfactory treatment.

Climax Molybdenum Company

500 Fifth Avenue
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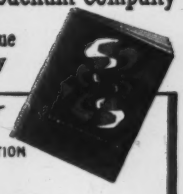

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FREE BOOKLET
3 KEYS TO SATISFACTION

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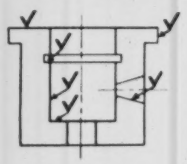
You Get ALL THREE with the PROFILOMETER

A Shop Tool for Microinch Roughness Measurement

***DEPENDABILITY:** The Profilometer is as dependable as a dial gage—eliminates uncertainties and errors common to "human" inspection methods. For any given path of trace, it always gives the same reading, directly in microinch units—today, tomorrow, or next year—no matter who is using it.

***SPEED:** The Profilometer is 8 to 25 times as fast as any other instrument of its type. And in the time required to compare a surface with roughness specimens, you can take *several* Profilometer readings. This speed of measurement lets you detect changes in roughness in time to correct production operations and prevent work spoilage.

***VERSATILITY:** The Profilometer measures practically all surfaces produced by machining, grinding or finishing operations—internal or external—straight, tapered, or circular—over any desired length of trace. With many surfaces, it provides the ONLY means for getting a roughness rating.



IN ADDITION, the Profilometer is rugged, portable, and simple to operate—*designed especially for shop use.*

ILLUSTRATED BULLETIN gives full details—shows many applications. Write for Bulletin L-6—and *arrange for a Profilometer demonstration in your plant.*

Profilometer is a registered trade name.

PHYSICISTS RESEARCH COMPANY

Instrument Manufacturers

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is explained, and its characteristics thoroughly discussed.

The entire book is well illustrated with circuit and vector diagrams, photographs and curves. A 21-page appendix includes tables of characteristics of conductors, inductive and capacitive reactance spacing factor values, coil burdens, and a relay application chart.

Silent Sentinels can be obtained by writing the Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa. In quantities up to 19 copies, a price of $3 each has been established, while if 20 or more are ordered, each sells for $2.70. Educational institutions can buy up to nine copies at $3 each, and ten or more for $2.00 each. All prices are net, postpaid.

General Electric's New Manual of Electric Instruments Now Available

A new, revised edition of General Electric's "Manual of Electric Instruments" has been announced by the Company's Meter and Instrument Divisions. The new edition describes the fundamentals of construction and operating principles of all major types of electric instruments.

Prepared primarily for use in schools, the manual also is designed for men in industry who wish to gain familiarity with the electric instruments with which they work. Its thirteen chapters explain the fundamentals of such instruments as thermocouples, synchroscopes, frequency meters, and electric telemeters. The 150 pages are extensively illustrated by photographs and diagrams. An added feature of this library-type textbook is a full reference index.

Priced at $1.00 per copy, the "Manual of Electric Instruments" (GET-1087A) may be obtained from the General Electric Co., Schenectady 5, N.Y.

Roller Chain and Sprockets

A new roller chain and sprocket catalog, the most complete of its kind ever assembled, is now available to design, development and production engineers.

The 72-page catalog has just been released by Morse Chain Co., Division of Borg-Warner Corp., manufacturers of roller and silent chains, sprockets, flexible couplings, friction and over-running clutches.

The 19-section catalog gives detailed information on design selection, service factors, rating tables, specifications and dimensions of standard roller chains and attachments.

Eighteen pages of the new Morse Roller Chain catalog are devoted to roller chain sprockets, their design features and dimensions.

Copies of the catalog may be obtained by writing on your letterhead to the Morse Chain Co., 7601 Central Avenue, Detroit 8, Michigan.

Automatic Control of Traveling Screen Cleaning

A schematic installation drawing and a typical wiring diagram are among the engineering details included in a new Application Engineering Data Sheet covering control of cleaning cycles for traveling screens. Copies of the Sheet 821-1 are available from The Foxboro Co., Foxboro, Mass., upon request.

The system, already in use in a large number of prominent power plants, steel mills, and other large water users depends upon the measurement of hydraulic loss across the trash rack and traveling screen.

It initiates automatic cleaning for a regular cleaning cycle. If, for any reason, the cleaning fails to reduce the loss across the screen, emergency alarms are provided to warn operators of unusual operating conditions.

• Keep Informed

Hallowell "Carry-Tool"

Standard Pressed Steel Co., Jenkintown Pa., announces the new "Carry-Tool" as the latest addition to their "Hallowell" Shop Equipment Line. The sturdy, easy-rolling "Carry-Tool" is a handy, time-saving, step-saving "carrier" in the shop . . . on assembly lines, at machines or in the tool room. Made of heavy-gauge steel, the "Carry-Tool" has large drawers that hold a full complement of tools. Ball-bearing rollers make drawers slide easily, loaded or empty. Padlock attachments protect contents. Full details are contained in Bulletin 715.

G.E. Offers Bulletin on Electrostatic Precipitation

A new 16-page, two-color bulletin on electrostatic precipitation, designated as GEA-5212, has been announced as available from the General Electric Co., Schenectady 5, N. Y.

Profusely illustrated with photographs and diagrams, the publication explains how electrostatic precipitation works, gives case histories of seven typical installations where the system is being used, and describes the various methods of electrostatic precipitation and the electric equipment applicable to each method.

Recognized as the most efficient method known today for the control of small particles of matter, either liquid or solid, electrostatic precipitation is used for air cleaning, gas cleaning and recovery, painting, deposition, orientation, and separation. It can collect cigarette-smoke particles as small as $^1/_{100,000}$ of an inch in diameter, or deposit fibers as long as $^1/_4$ inch on an adhesive-coated cloth to make pile rugs. It is finding application in acid plants, blast furnaces, carbon-black plants, cement plants, gas plants, oil refineries, power plants, pulp and paper mills, smelters, textile mills, and elsewhere.

Iso-Flow Steam Generators and Iso-Flow Furnaces

Petro-Chem Development Co., Inc. of New York City have issued two Technical Bulletins: 50-1 and 50-2, which describe and illustrate their Iso-Flow Steam Generators and their Iso-Flow Furnaces. Bulletin 50-2 contains a detailed summary of the design and operating characteristics and operating test data on a 30,000 lb. per hr. Iso-Flow Steam Generator installation. Bulletin 50-1 describes and illustrates the Petro-Chem Iso-Flow Furnace, Radiant Convection Design, and includes the significant design and operating characteristics of these cylindrical furnaces which are in extensive use throughout the petroleum, chemical and allied industries. Copies of Petro-Chem Development Company's Bulletins 50-1 and 50-2 are available upon request.

New Valve Selection Chart

A handy, new reducing valve selection chart is available from Kliptel Valves, Inc., Division of Hamilton-Thomas Corp., Hamilton, Ohio. The chart is useful to anyone who has to specify valves occasionally and who does not have all the engineering background necessary to do the job easily.

By reference to the service for which the valve is intended, the reduced pressure limits and other factors, selection of the correct valve can be made easily and expertly.

Used in conjunction with Kliptel Reducing Valve Bulletin No. 148, the chart also helps determine proper sizes of valves. Too often valve sizes are determined solely from pipe sizes, usually resulting in a valve much too large for the required flow. Such oversize valves will operate in a nearly closed

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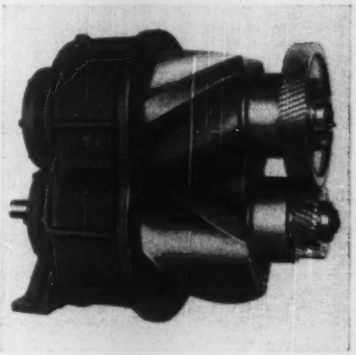
STANDARDAIRE

Precision Built Axial Flow



BLOWERS handle the movement of air gently by screw action instead of paddle action, as is the case with other positive displacement blowers. Result — air pulsations and noise are reduced to a surprisingly low level. In Standardaire Blowers the revolutionary new form of the rotors marks a major improvement in blower design. The rotors are produced by an exclusive rotary generating process, the form and helix being controlled entirely by the machine gears. This produces rotor threads that are accurately shaped and machined to close tolerances for efficient blower operation. The design of the rotors and other construction details makes possible internal compression to a degree that Standardaire Blowers operate on a modified adiabatic cycle with a lower mean internal pressure. This important feature, together with advanced engineering throughout, makes for a quiet, compact, efficient blower with long service life.

Write for Standardaire Blower Bulletin covering dimensional information. Publication No. 88.

The Standard Stoker Company, Inc., Dept. C-2, 370 Lexington Ave. New York 17, New York

Standardaire Blower equipped with unique pulley attachment for belt drive, when required.

THE STANDARD STOKER CO • INC •

Standard Stoker

NEW YORK • CHICAGO • ERIE • MONTREAL

position and are subject to wire-drawing and chattering. Accuracy of regulation is also affected.

The chart also clearly indicates which valves are suitable for dead-end service and which are not. Klipfel engineers have found that in many cases valve users will specify for dead-end service valves which are not tight closing. The valves thus chosen prove to be unsatisfactory, of course, and often dangerous to the users.

Copies of the new valve selection chart and Reducing Valve Bulletin No. 148 are available from Klipfel Valves, Inc. on request.

Babcock & Wilcox Tube Co. Offers Handy Reference Table

A linear conversion table for handy reference by engineers, who frequently wish to convert inches and fractions of inches into decimal parts of a foot, has been printed by The Babcock & Wilcox Tube Co. The table is suitable for many purposes in addition to those encountered in the application of steel tubing, the company says.

Known as TDC-110 the table is arranged on a single card and is available free to interested parties upon request from the home office of The Babcock & Wilcox Tube Co. at Beaver Falls, Pa.

New Bulletin Describes Steel Plate Production Facilities

A bulletin recently issued by the Posey Iron Works, Inc., of Lancaster, Pa., gives a comprehensive, thoroughly illustrated description of this firm's production facilities. Specific plant acreage is given and new machinery is shown. Products are also illustrated. Sent free.

Revised Micarta Data Book Available

Copies of the recently-revised 36-page Micarta Data Book are available from the Westinghouse Electric Corp., manufacturers of this industrial plastic. Published as a working tool for the designer and user of industrial materials, the Data Book presents clearly and completely the technical facts about Micarta.

The grades and forms in which Micarta is supplied are tabulated, together with the chemical, mechanical and electrical properties of each. Standard shapes and sizes available are listed, and a description of finishes is included.

For a copy of this booklet (B-3184-D) write the Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

Gerotor Air Cylinder Catalog

The entire line of Gerotor air cylinders is illustrated and described in the new Catalog Section No. 54 just published by Rivett Lathe & Grinder, Inc., Boston, Mass.

The design of the new 16-page, two-color, $8^1/_2 \times 11$ catalog has been directed to helping the engineer lay out his air circuit. Drawings and tables are furnished for each model and size cylinder showing complete detailed dimensions. Cylinder mountings which are described include Rabbet, Foot, Trunnion, Center Line, Blind End Flange, Rod End Flange, and Clevis. Types and model valves most suited to various applications are also recommended.

Prominent features of Gerotor double acting, non-rotating air cylinders outlined in Catalog Section No. 54 are: Keeper ring construction eliminates tie rods to permit more compact design and allow more convenience in locating pipe connections; and self adjusting composition rod and cup packings eliminate hand service.

Catalog Section No. 54 may be had by writing Rivett Lathe & Grinder, Inc., Brighton 35, Boston, Mass., mentioning this magazine.

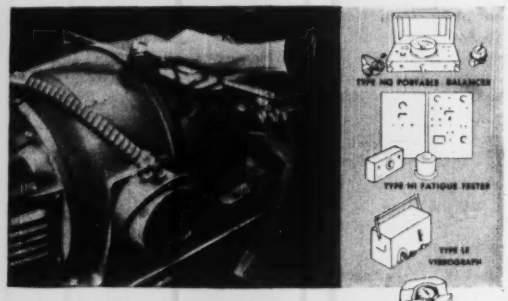
S. P. S. Bench Bulletin

Standard Pressed Steel Co., Jenkintown, Pa., announces the immediate availability of their latest Bulletin 701 on "Hallowell" Work Benches. This attractive Bulletin contains full information and illustrations as to Construction and General Information; How To Order; Sizes, Models and Catalog Numbers; Bench Drawers and Drawer Tiers; Bench Legs; Bench Tops; and Parts and Accessories.

Felt

American Felt Co., 50 Glenville Road, Glenville, Conn. has available 15 Data Sheets giving technical information about felt, and including illustrative samples: The list is as follows: 1, Felt Density and Hardness; 2, Adhesives for Felt Application; 3, "K" Felt—Sound Absorption and Thermal Insulation; 4, Special Felt Treatments; 5, S.A.E. Specifications; 6, Wicks and Lubrication; 7, A.S.T.M. Methods of Test for Wool Felt, D461; 8, U.S. Army Specification No. 8-15G; 9, Sheet Felts; 10, Vibration Isolation; 11, Felt Seals; 12, Flame-Proofed Felt; 13, Felt in Compression; 14, Vistex—Packings, Gaskets, Seals; 15, Felt and Filtration. There is also a special S.A.E. Folder. When writing please state topic in which you are interested.

YOU CAN BE SURE.. IF IT'S Westinghouse



TYPE MH VIBROMETER

Measure Vibration *in a hurry!*

Track costly vibrations with inexpensive tools. The Westinghouse Types MH and JC-1 Portable Vibrometers are instruments that supply immediate readings of amplitude and frequency respectively. They provide data essential for elimination of harmful vibration. For complete information on this and other vibration testing equipment, write Westinghouse Electric Corporation, Department E-3, 2519 Wilkens Avenue, Baltimore 3, Maryland. J-02211

Westinghouse VIBROMETERS

New! di-acro BOX FINGER BRAKE

Four models 6" 12" 18" 24"
Capacity—16 Gauge Steel

3 TOOLS IN ONE
1 BOX and PAN BRAKE
2 STANDARD BRAKE
3 BAR FOLDER

One box or 10,000—can be economically produced with the versatile new Di-Acro Box Finger Brake. Serves perfectly for all standard brake operations—an Acute Angle Bar converts the brake to a bar folder for locks, seams, hems and sharp angles. The unique Di-Acro Open End Finger forms square or triangular tubes and other similar parts. The Box Finger Bar can be easily mounted on all standard Di-Acro Brakes.

Send for 40 PAGE CATALOG describing DI-ACRO Shears, Punches, Benders, Brakes, Notchers and Rod Parters—also Power Shears and Benders.

Di-Acro is pronounced "DIE-ACK-RO"

DI-ACRO O'NEIL-IRWIN MFG. CO.
308 EIGHTH AVENUE, LAKE CITY, MINN.

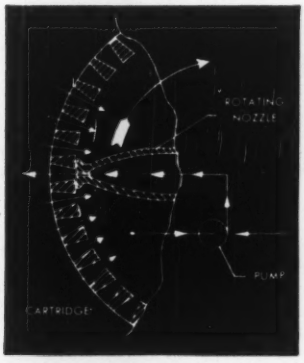
Save Water Automatically

and save money, too!

If water's scarce in your community, here's a painless way to cut down consumption.

If water isn't scarce yet, it's still expensive (particularly if you have to heat it or treat it), and here's an easy way to cut down its cost.

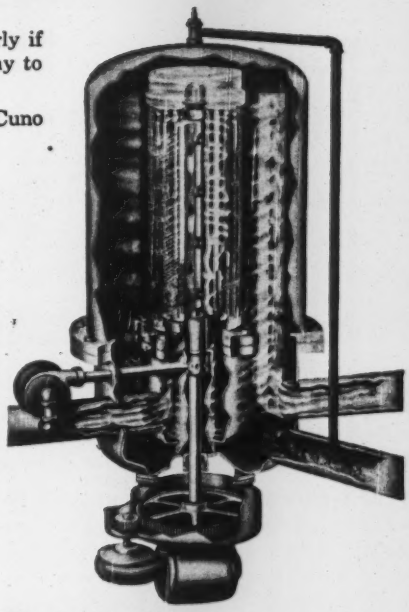
Make dirty water *fit for use* and *re-use* with a Cuno FLO-KLEAN Strainer.



Permanent, Resists Abrasion and Corrosion

Cuno Flo-Klean Filter makes raw water suitable for many plant services . . . keeps recirculated water clean . . . *pays for itself in as short a time as a year.* Permanent wire-wound cartridge positively removes all solids larger than spacing specified.* Pressure drop is exceptionally low because fluid moves in a straight line, encountering only momentary restriction.

**Available spacing from .0025 in. to .020 in.*



Continuously self-cleaning without fluid waste

There is no loss of backwash fluid. Used backwash is returned to the system. With no interruption of flow for cleaning the strainer, no duplex installation is needed. Operation, including sludge removal, may be completely automatic.

No Fluid Is Better Than Its Filtration

CUNO

Complete Line Fluid Conditioning

Removes More Sizes of Solids from More Types of Fluids

MICRONIC (MICRO-KLEAN) DISC-TYPE (AUTO-KLEAN) WIRE-WOUND (FLO-KLEAN)

Find Out How to Save Money

cleaning any fluids containing abrasives

CUNO ENGINEERING CORPORATION
639 South Vine St., Meriden, Conn.

Please send information—without obligation—on Cuno FLO-KLEAN for application noted:

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Name.....Title.....
Company.....
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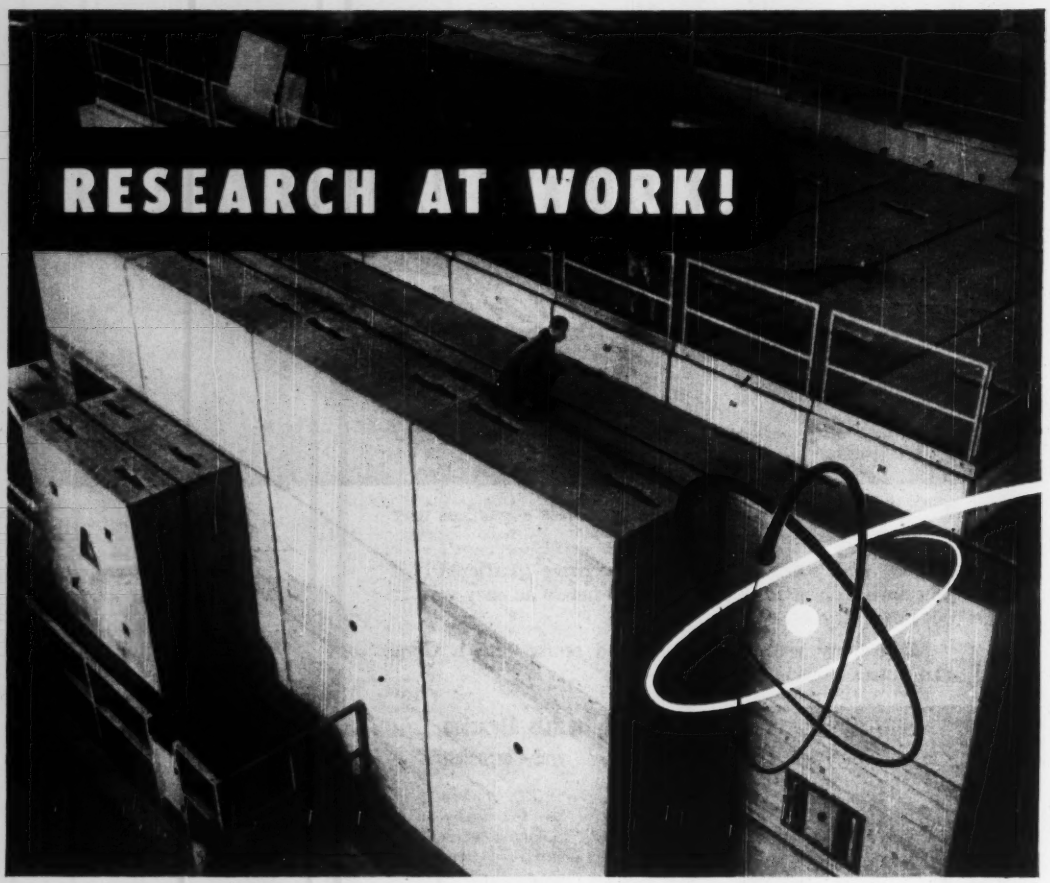
PLEASE ATTACH COUPON TO YOUR BUSINESS LETTERHEAD



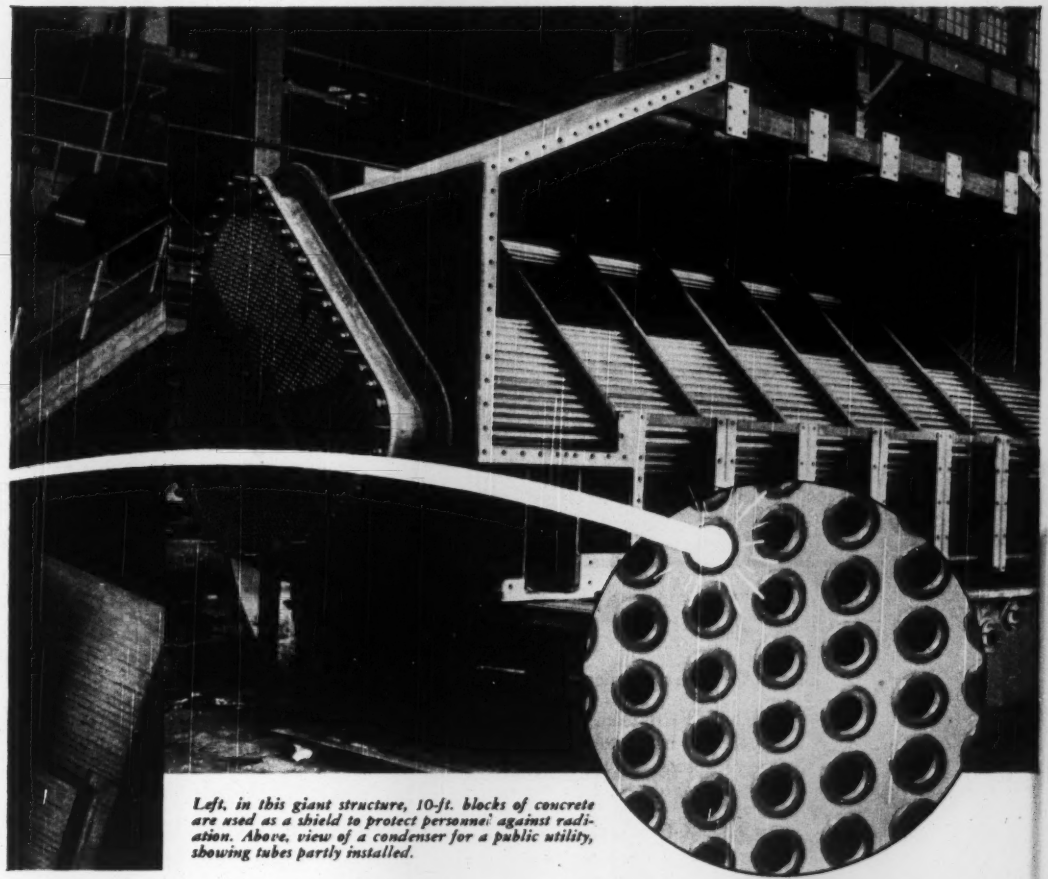
Long before Hiroshima, Revere used the atom—constructively

BEFORE the first atomic pile was built, before the first atomic bomb was exploded, Revere used the effects of the disintegrating atom for constructive research. It was in 1941 that radio-active tracer elements were employed in a Revere-sponsored investigation into the destructive process known as dezincification. This is a form of corrosion formerly of chief concern to users of copper-zinc alloy condenser tubes. In this process the alloy seems to be dissolved from localized areas, the zinc going off in solution while the copper is re-deposited as a porous plug.

A number of years ago it was found by experiment that the addition of small amounts of some other element would prevent or inhibit this electro-chemical action. Nobody knew just why or how, nor what was the best percentage for the third element. Revere decided to find out, and commissioned two able scientists in a famous Eastern technical school to conduct the necessary experiments.

In this work, radio-active elements or isotopes were produced in a cyclotron, and were used in order to determine the function of those elements in rendering the alloy more resistant to corrosion.

Briefly, the method was this: The desired radio-active element was dissolved in an acid, and the solution's radio-activity calibrated by means of a Geiger counter. A standard sample of the alloy was immersed in the solution, and from time to time the amount of the active element deposited upon it was measured with the counter. The nature of the deposited film was also checked by the electron diffraction method. This



Left, in this giant structure, 10-ft. blocks of concrete are used as a shield to protect personnel against radiation. Above, view of a condenser for a public utility, showing tubes partly installed.

was in effect an accelerated test for dezincification and its inhibition. It was repeated many times with solutions of various concentrations. This, mind you, was in 1941, before radio-active tracer procedures were of any interest except to a comparatively few scientists.

The conclusions reached as a result of these tests can be summarized as follows: The corrosion of uninhibited copper-zinc condenser tubes occurs by solution of the alloy as an entity. When an inhibitor is present, however, in the percentages revealed by the experiments, the inhibitor is re-deposited on the alloy as a film which has about the same effective electrical potential as copper. The deposition of copper is thereby prevented. One of the key processes in dezincification having been thus interrupted, the process itself is effectively stopped, or at least so reduced in activity as to provide corrosion resistance, and commercial service, for extremely long periods of time. Thus the inhibited copper-zinc alloy condenser tube has become reliable and economical to an extent heretofore unrealizable.

Realistic Revere Research

Often the word "research" is thought to mean startling new discoveries and swift, amazing inventions. The fact is, however, that research does not work that way. Such modern devices as the automobile, the airplane, the telephone, radio, television, and numerous others would indeed be startling if they had been developed overnight. As we all know, they have reached their present high degree of development as a result of continuous improvement, detail after detail, problem after problem being worked out through countless hours and even years of the most painstaking research.

Revere's research is of that type. It is a continuing search for better knowledge of its materials and processes, and the way its metals may be utilized with the greatest efficiency and the maximum economy. This is not spectacular, but over the years it has made many contributions to the farm, the home, and industry.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

THIS MAN WOULDN'T NEGLECT

A MACHINE IN HIS PLANT

...yet he hasn't had a Chest X-Ray!

He checks every piece of mechanical equipment he owns for wear, lubrication, efficiency.

Yet he fails to take the simple precaution of a Chest X-Ray to make sure he does not have tuberculosis. *Not because he's opposed to the X-Ray. Simply because he is not sufficiently informed—or just hasn't taken the time and trouble, or does not realize the seriousness of the problem.*

A Chest X-Ray is the first step toward detecting tuberculosis in its early stages. And in its early stages it can be cured with the least loss of time from work.

So, if you're the man above, that one simple reason should make you get your Chest X-Ray—*today*. But listen, see how serious this really is:

Between the ages of 15 and 34, tuberculosis leads all other diseases as a cause of death—although at no age are you safe from TB. Yet, if everyone does his part by getting a Chest X-Ray periodically, and the majority of cases thus discovered are followed up, we can eliminate TB entirely as a public health hazard!

Will you do your part today? Get a Chest X-Ray. It may mean your life!

Published in the public interest by:

MECHANICAL ENGINEERING

NOW Line-O-Power

STRAIGHT LINE DRIVES

DOUBLE REDUCTION

TRIPLE REDUCTION

high quality
economy
efficiency

CHECK THESE Line-O-Power features

✓ **ECONOMICAL TO BUY**—Lower original cost because these units are designed for manufacture on latest and most accurate high production machine tools.

✓ **ECONOMICAL TO OPERATE**—Straightforward, enclosed offset shaft principle of design gives efficiencies of 96% or higher. Simplified construction—minimum number of moving parts—direct splash lubrication—quality workmanship hold maintenance to a minimum.

✓ **DUTI-RATED HELICAL GEARS**—Duti-Rated high hardness helical gears manufactured to rigid standards assure exceptional accuracy, long life and dependability.

✓ **MODERN APPEARANCE**—The last word in clean-looking, modern design. The streamlined Line-O-Power unit on original equipment highlights the designer's approach to functional, efficient equipment.

✓ **COMPACT — SAVES SPACE** — Compact because the entire housing volume has been utilized to attain speed reduction. Placement of input and output shafts in a direct line brings the coupled motor and speed reducer into a narrow line of power transmission.

✓ **LARGE OVERHUNG LOAD CAPACITY**—Conservatively selected, large capacity antifriction bearings and husky output shafts assure maximum overhung load capacity.

✓ **STURDY HOUSINGS**—The housings of Line-O-Power Drives are rugged, dense, sturdy castings to give maximum rigidity and minimum deflection under load.

✓ **LARGE RANGE OF SIZES AND RATIOS**—A large range of double and triple reductions for capacities from 1 to 200 horsepower. Ratios from 5 to 1 up to 238 to 1 available for prompt delivery.

✓ **APPLICATION ADAPTABILITY**—Line-O-Power drives will transmit power from any prime mover and are adaptable for horizontal side-wall or ceiling mounting upon order.

Here is a newly developed drive that offers high quality combined with economy both in original cost and in operation.

Line-O-Power Units use Foote Bros. Duti-Rated high hardness helical gears for long life, quiet operation and compactness.

Line-O-Power Drives are the last word in modern symmetrical design. Wherever enclosed gear drives are used, they assure a clean-cut, efficient power package unit.

FOOTE BROS. GEAR AND MACHINE CORPORATION
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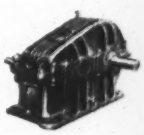
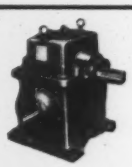
FOOTE BROS.

Better Power Transmission Through Better Gears

Foote Bros.-Louis Allis Gearmotors



Maxi-Power Helical Gear Drives



Hygrade Worm Gear Drives

WRITE FOR BULLETIN LPA

Foote Bros. Gear and Machine Corporation
Dept. Q, 4545 S. Western Blvd.
Chicago 9, Illinois

Please send me a copy of Bulletin LPA on Foote Bros. Line-O-Power Drives.

Name .....

Company .....

Position .....

Address .....

City ..... *State* .....

YOU DON'T HAVE TO PAMPER

THE "King-clip" VALVE!

Fig. 1640
Iron Body Bronze Mounted "KING-CLIP" Gate Valve 150 lb. S.P.—200 lb. W.O.G. For steam, water, gas, air, oil and gasoline service.

THIS STURDY IRON BODY GATE VALVE is built to stand the gaff of hard usage. It is a composite of the strong construction of the original "Clip" valve pioneered by Lunkenheimer many years ago and improved design features to meet modern-day conditions. It provides maximum resistance to distortion, piping stresses and wrenching strains.

Aside from its basic rugged proportions, the "KING-CLIP" embodies these distinctive features: • non-corrosive stem-thread bearing cast in bonnet • large drain channels that really drain the bonnet • sharply tapered bronze disc that seats tight • bronze rolled-in seat rings • coarse stuffing box threads that resist corrosion and stripping • hexagon head gland • Lunkenheimer-developed stem material that eliminates stem-thread failure due to wear • easy disassembly for servicing.

Ask for Circular No. 561 which illustrates the numerous patterns in which the "KING-CLIP" is available—iron body trim with bronze and various alloys, and all-iron . . . for a wide variety of services. You'll find one or more types which you can use to profitable advantage.

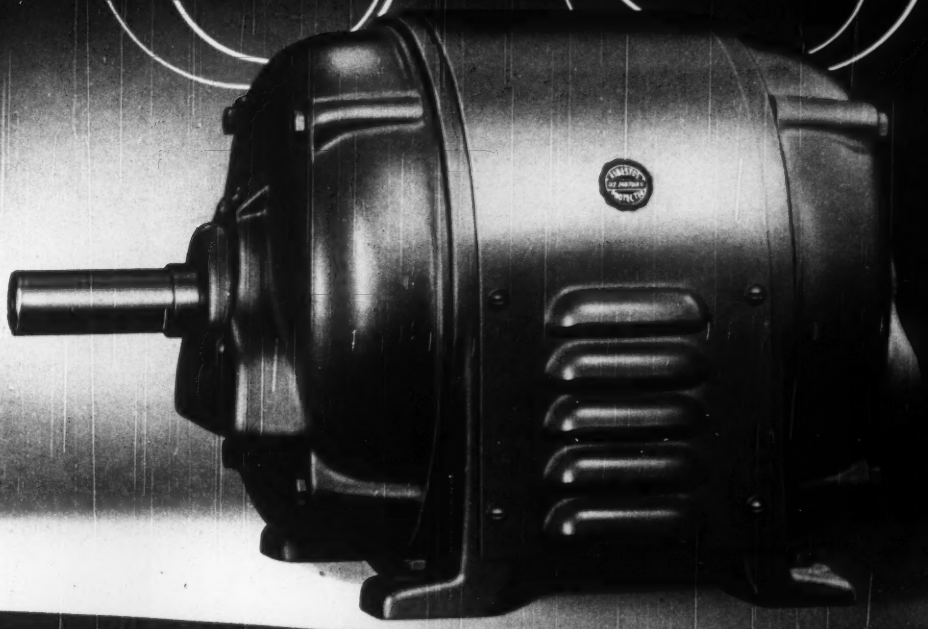
LUNKENHEIMER DISTRIBUTORS
save you money...and "headaches"!

Distributors' stocks and service are a money-saving and time-conserving convenience. The more you use these handy facilities, the less you need spend for stock-room inventory and "sleuthing" for sources of supply. Call your Lunkenheimer distributor and profit from his unfailing service—not only on valves, but on the numerous other commodities necessary to keep industry in pace with the needs of these fast-moving times.

ESTABLISHED 1862
THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI 14, OHIO, U.S.A.
NEW YORK 13 · CHICAGO 6 · BOSTON 10 · PHILADELPHIA 34
EXPORT DEPT. CINCINNATI 14, OHIO, U.S.A.

The "King-clip" is king of all clip type valves!

US UNICLOSED MOTOR



. . . the Armored Motor

COMPLETELY SHIELDED

US MOTORS

(See next page)

1

ARMOR-CLAD WINDINGS
Asbestos Protected

2

LONGER BEARING LIFE
With Lubriflush

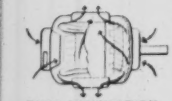
3

NORMALIZED CASTINGS
Maintain Accuracy

4

UNICLOSED CONTOURS
Give Extra Protection

5

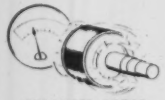


DUAL VENTILATION
For Ever-Cool Operation

6

SOLID CENTRICAST ROTOR
With Integral Fans

7



BALANCED ROTOR
Eliminates Vibration

8

ANNEALED LAMINATIONS
For Lasting Economy

9

PRECISION MACHINING
Matches Bearing Accuracy

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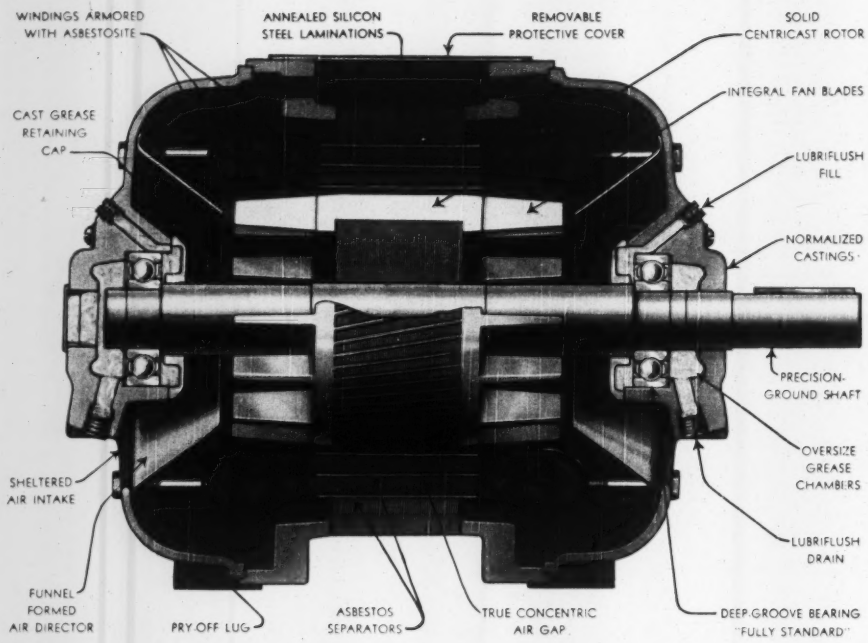
GUARANTEED SATISFACTION
Nation-Wide Service

U.S. UNICLOSED MOTOR



THE MOTOR THAT GIVES YOU MANY PLUS VALUES

The Uniclosed is no ordinary motor. It combines external protection with interior perfection. The vital operating parts are armored against damage from moisture, falling debris, dust and dirt. The Uniclosed is suitable for many conditions ordinarily requiring more expensive splash-proof or enclosed designs. Asbestos-protected windings guard against carbonization. Lubriflush lubrication insures longest life of bearings which are *self-lubricated* for normal life. Normalization of all castings insures permanent bearing alignment. Dual cyclone ventilation insures a cool running motor in high atmospheric temperatures. The rotor is centricast. The steel laminations are annealed to prevent excessive electrical loss.

Request these two interesting, informative bulletins.

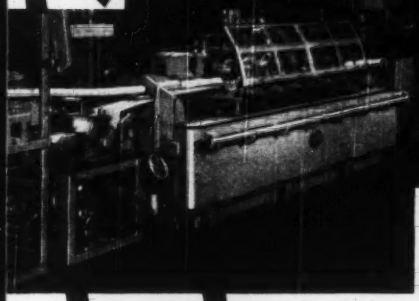
Write today for Bulletins featuring U. S. Uniclosed and U. S. Sanitary motors. These products are illustrated in natural colors. Details of construction reveal many features of interest to cost-minded plant operators seeking the most dependable economical power. If your power requirements include variable speed, ask for Bulletin featuring U. S. Varidrive Motors.

U.S. ELECTRICAL MOTORS Inc.

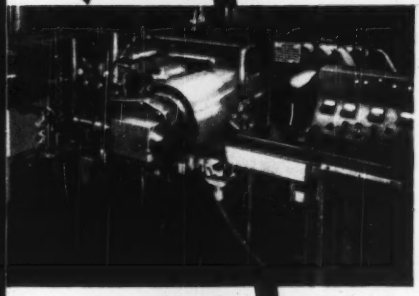
PACIFIC PLANT: Los Angeles 54, California **ATLANTIC PLANT: Milford, Connecticut**

Atlanta 3, Ga.; Bakersfield, Calif.; Boston 16, Mass.; Chicago 8, Ill.; Cincinnati 16, Ohio; Cleveland 14, Ohio; Dallas 9, Texas; Detroit 2, Mich.; Fresno 1, Calif.; Houston 4, Texas; Indianapolis 4, Ind.; Milwaukee 2, Wisc.; Minneapolis 2, Minn.; New York City 6, N. Y.; Philadelphia 2, Pa.; Pittsburgh 2, Pa.; San Francisco 7, Calif.;
Distributors and Agents in all principal cities.

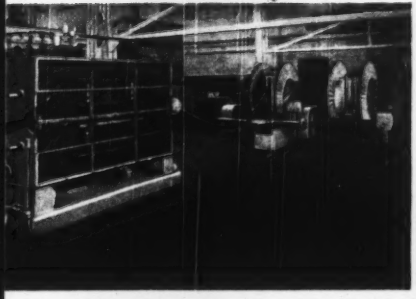
Oilgear unit drives cable take-up reels. By an ingenious Oilgear control arrangement, all units are kept in perfect step over entire 150 feet of Alpeth sheathing process.



Oilgear fluid p[illegible]r drives Yoder roll forming machine which [illegible]aps corrugated aluminum sheathing arou[illegible]able.



Oilgear drives [illegible] synchronized to speed of Royle e[illegible]der which covers cable with melt[illegible]olyethylene.



Tractor capstan powered by Oilgear, which pulls cable through extruder, long cooling trough and inspection station.

WESTERN ELECTRIC'S

OILGEAR FLUID POWER

● Right after the war, the Bell System faced a tremendous problem because of the shortage of lead for sheathing telephone cable. To solve that problem, a newly designed sheath known as Alpeth—aluminum polyethylene—was adopted. And the engineers had to design a machine fast that would apply this sheath fast—to produce this new cable by the millions of feet.

Oilgear engineers, working with *standard* Oilgear Fluid Power pumps, motors and valves, met the need for drives that would handle the complex Alpeth coating machines, dependably, without trouble . . . and for drives that could be immediately, easily and economically installed . . . requiring minimum space, sure performers from the start.

The first Alpeth cable sheathing machines installed by the Western Electric Company proved themselves and more units were installed, to make a total of three at the Kearny, N. J., Works and three at Hawthorne Works in Chicago. The Oilgear drives have performed well, without trouble, with minimum maintenance, often at high speed for 24 hours a day.

A company like Western Electric does not buy by guesswork. Neither should you. THE OILGEAR COMPANY, 1570 W. Pierce Street, Milwaukee 4, Wisconsin.

Oilgear

PIONEERS IN FLUID POWER

YOU CAN BENEFIT BY THIS A.S.M.E. INTEREST

1950 Power Show to Be Under ASME Auspices

ANNOUNCEMENT was recently made that the 19th National Exposition of Power and Mechanical Engineering will be held under the auspices of The American Society of Mechanical Engineers. It will be at Grand Central Palace, New York, N. Y., Nov. 27–Dec. 2, 1950, and will be held at the same time and in conjunction with the ASME Annual Meeting.

Since the inception of the Power Show in 1922, ASME has always co-operated with the Exposition and has had a booth in a prominent location near the main entrance to the Exposition. This year, however, is the first time that the Power Show is being held under the auspices of ASME.

Management of the Exposition remains as in the past in the hands of the International Exposition Company, who also manage the International Heating and Ventilating Exposition, the Exposition of Chemical Industries, and the Electrical Engineering Exposition. Permanent headquarters are at Grand Central Palace, New York, N. Y.

Mechanical Engineering, April, 1950

A BIGGER OPPORTUNITY than ever to *SHOW... TELL... SELL...* your prime prospects.

Currently increasing interest on the part of industrial managements and operating officials in obtaining greater plant efficiency—lower production costs—wider profit margins in the face of today's keener competitive conditions places on power and plant engineers, a greater responsibility than ever to find new ways and means to accomplish these objectives. The Power Show is one place they are sure to be looking for new cost-saving opportunities in equipment, instruments, and supplies—don't disappoint them. Thousands of your best customers and prospects will be here... in a receptive mind... away from business concerns... eager to see first-hand what your latest products look like... how they operate... why they're good buys for reducing plant operating and maintenance costs.

RESERVE SPACE NOW

Apply now for space diagrams, rates and data. Get your space reservations in early to assure good location. Nearly 300 leading manufacturers have already engaged space at this important event. You can make no better investment in selling steam, electrical and mechanical power equipment.

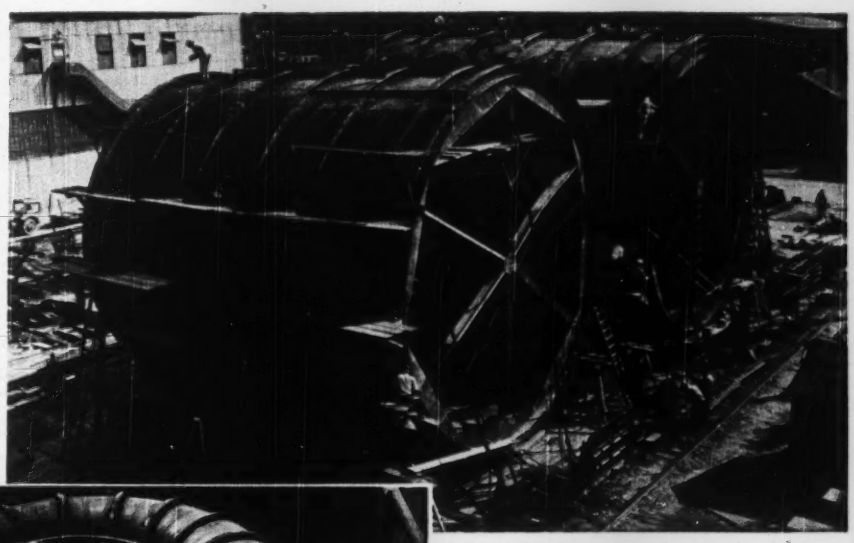
19th NATIONAL POWER SHOW

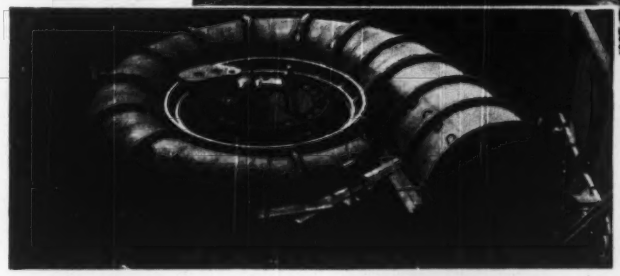
NATIONAL EXPOSITION OF POWER & MECHANICAL ENGINEERING

GRAND CENTRAL PALACE, N.Y.

NOV. 27 to DEC. 2

MANAGEMENT INTERNATIONAL EXPOSITION COMPANY — GRAND CENTRAL PALACE, NEW YORK 17, N. Y.





TO HARNESS THE ELEMENTS

Shown are shop erections of sections of a wind tunnel and a water turbine spiral casing at Newport News. One to be used in the development of America's planes of the future, the other to generate power in the world's largest hydro-electric development.

Tolerances required for the 34-foot diameter welded structure of the wind tunnel were: flushness or smoothness plus or minus 0.01″; fairness of structure 0.03″ and up to $^{1}/_{32}$″ in diameter.

Eighteen of the 165,000 horsepower turbines at Grand Coulee have been built by Newport News. Nine sections of the casings are cast steel and six are welded and cast. These turbine units are the most powerful ever built.

Refractory towers, pressure vessels, bridge caissons and other heavy equipment of special design are fabricated at Newport News. The plant, over a mile in length, includes welding and steel fabricating shops, machine shops, foundries and forge shop to provide the advantages of building the complete job.

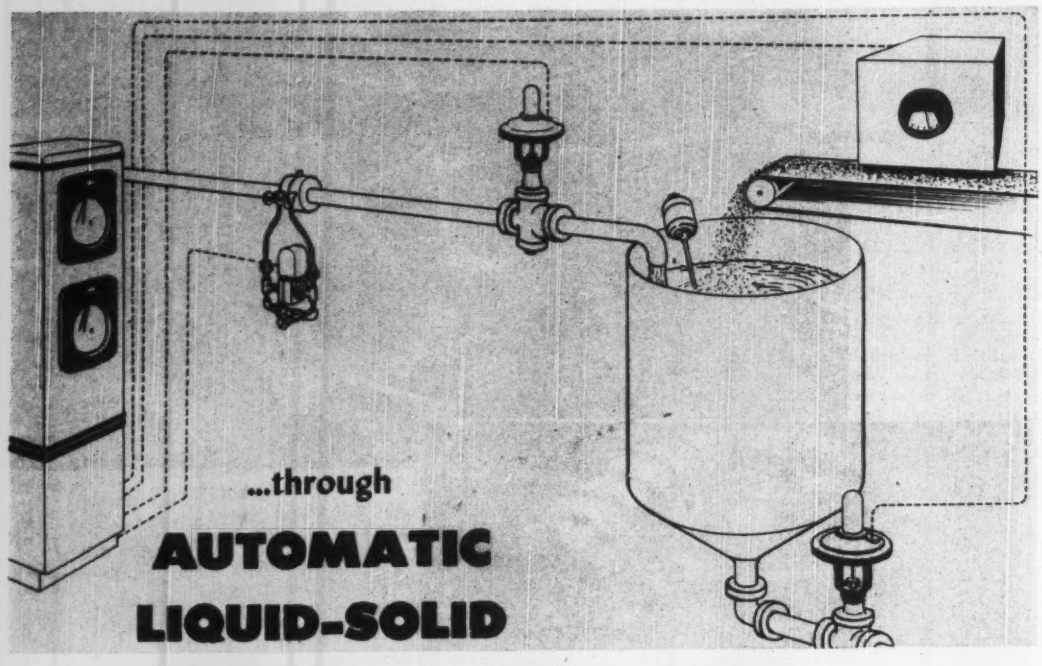
"Facilities and Products" catalog will be sent if requested.

NEWPORT NEWS

SHIPBUILDING AND DRY DOCK CO.

NEWPORT NEWS, VIRGINIA

NEW OPPORTUNITIES in continuous processing



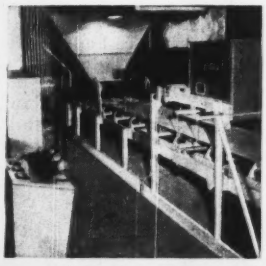
RATIO CONTROL...by Foxboro

Many a troublesome batch process can be converted to continuous operation — with resulting economies and product improvement — by installing Foxboro Liquid-Solid Ratio Control. This simple, accurate system has been thoroughly proved in use on such processes as the extraction, dissolving, or reaction of materials.

Typical examples include the proportioning of acid feed to phosphate rock in the production of phosphate fertilizer, and the proportioning of water to the feed of cossettes (sliced beets) in the production of beet sugar. *Wherever ratio-ing the quantity of liquid reagents to a varying rate of solid chemicals being delivered by a conveyor belt is desirable, this fully automatic system simplifies the operation and improves the efficiency of the process.*

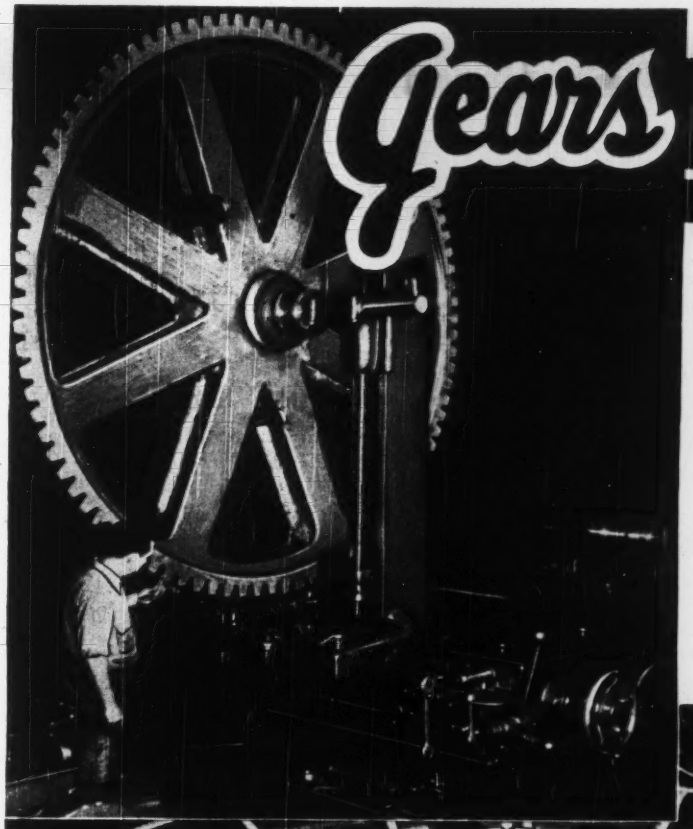
In this system, a Foxboro Recording Controller receives a continuous measurement of weight of the solid material (from a Foxboro Pneumatic Motion Transmitter incorporated in a Merrick Weightometer located above the conveyor belt), and also receives a continuous measurement of liquid flow from a Foxboro d p Cell or mercury manometer. The desired ratio between solid and liquid can be readily set by a dial in the instrument which, in turn, controls the liquid flow.

The efficiency-boosting advantages of Foxboro Ratio Control are now being realized by a number of leading companies. If you have a similar problem, learn how these advantages may be achieved for your plant. Write for engineering data. **The Foxboro Company, 182 Neponset Ave., Foxboro, Mass., U. S. A.**



This illustration shows Foxboro Ratio Control at a large beet sugar plant. A Merrick Weightometer equipped with a Foxboro Pneumatic Motion Transmitter appears in the foreground.

FOXBORO
REG. U. S. PAT. OFF.
COORDINATED CONTROL



Gears LARGE ... ANY TYPE

Huge gears for every industrial use, also for the Army, Navy and other governmental services as well . . . that is our background for over 58 years. Our modern plant contains the latest machines for cutting, machining, hardening and testing every type of gear: Herringbone, Helical, Spur, Spiral-Bevel, Worm, Hypoid, Zerol, Internal, Intermittent, Racks and Pinions, etc.—*large* and *small*, in any quantity. That is why we have been known as "Gear Headquarters" throughout the years.

PHILLIE GEAR

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON
IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

Why Bundyweld is

HOWEVER you use tubing . . .

Wherever you use tubing, for all-round better performance just check on famous Bundyweld Tubing. For no other tubing is made like Bundyweld.

From fabrication to finished product, Bundyweld gives advantages no other tubing can promise, often including major savings in cost. Sweet music to *any* manufacturer!

Just note the Bundyweld highlights below.

BUNDYWELD'S SUPER FOR BRAKE LINES IN CARS; IT RESISTS THE FATIGUE FROM BOTH SHIMMIES AND JARS.

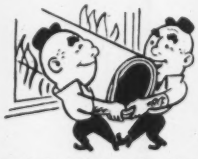
Every sleek new automobile rolling off the assembly lines today averages about 20 different parts of rugged Bundyweld Tubing. Of those same cars, 95% have hydraulic brake line systems of Bundyweld, too! What better evidence of the *strength, durability* and *high fatigue endurance limit* Bundyweld can assure in your applications, too?

WE TAKE A FLAT STRIP, ROLL IT TWICE ALL ITS LENGTH; GET A DOUBLE-WALLED TUBING THAT'S FAMOUS FOR STRENGTH.

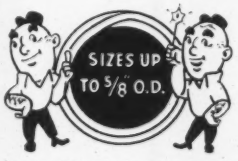
Secret of Bundyweld's amazingly long list of features is its special, patented construction. It's double-walled from a single strip, the *only* tubing of its kind. Put it in that tough spot in your design, structural or functional applications. Bundyweld can stand the gaff!

First, a single strip of basic metal, coated with a bonding metal, is . . .

rolled twice around into a tube of uniform thickness, then . . .



passed through a furnace. Bonding metal fuses with basic metal, presto—



Bundyweld . . . double-walled and brazed through 360° of wall contact.

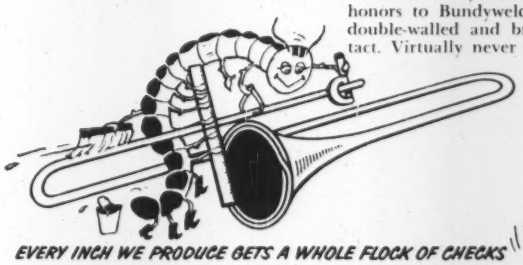
the better tubing

MACHINE IT OR BEND IT, SWAGE IT OR FLARE IT;
FOR SMOOTH, EASY HANDLING YOU JUST CAN'T COMPARE IT!

With all its sturdiness, Bundyweld is easy to cut, machine, form or join. It bends more readily and takes more bending without collapsing or weakening structurally. Your tip-off to faster, smoother fabrication and lowered costs of tubular frames, refrigerant lines, beer coils, radiant heating systems, or a product you may be designing that happens to need a *better* tubing.

NO LEAKS UNDER STRESS IN YOUR LINES OR YOUR COILS;
BUNDYWELD'S PERFECT FOR GASES AND OILS.

High resistance to pressure your big must? Bundyweld is still your tubing! Halogen vapor leak detector tests, accurate for 1/100 of an ounce leak *per year*, give honors to Bundyweld for leakproof performance. It's double-walled and brazed through 360° of wall contact. Virtually never a chance of a leak!



SO, make it a point to find out today
How *your* use of Bundyweld really can pay.
Be it nickel or steel or Monel, you will find
No other tubing so soundly designed.

EVERY INCH WE PRODUCE GETS A WHOLE FLOCK OF CHECKS FOR FREEDOM FROM SCALING AND OTHER DEFECTS.

Bundyweld's wall thickness and concentricity are steadily held to amazingly close tolerances. No scaling! Coating, inside and out, is always smooth, clean, bright. Your inspection processes can be pared to a minimum, without delays for rejects. Still more Bundyweld savings for you.

FREE! Write today for new 20-page, illustrated booklet on Bundyweld Tubing, its properties, uses and how it can be fabricated, plus helpful information that may steer you to a profitable application of Bundyweld in your product. For your free copy, or queries on any possible use of Bundyweld, just call or write:
Bundy Tubing Company, Detroit 14, Michigan.

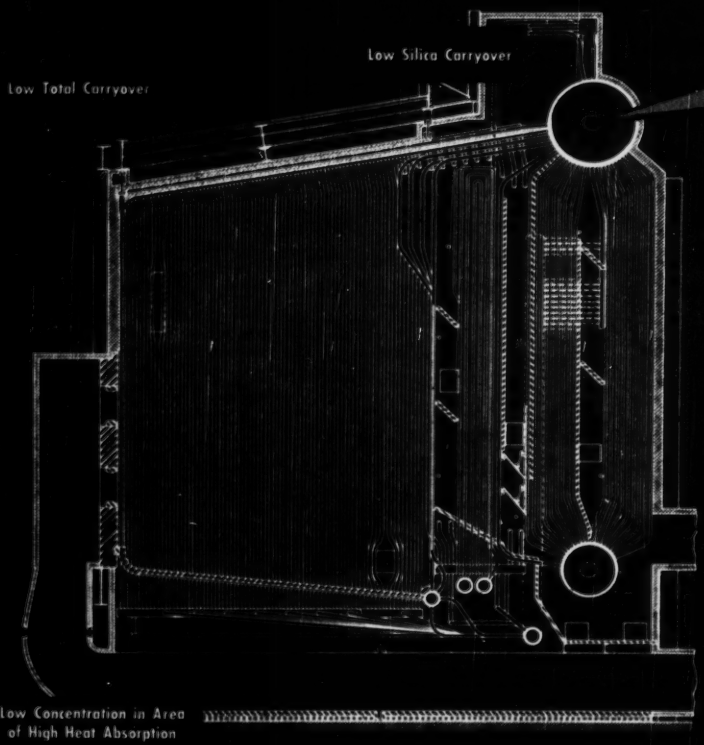
Bundyweld® Tubing

DOUBLE-WALLED FROM A SINGLE STRIP

Bundy Tubing Distributors and Representatives: Cambridge 42, Mass.: Austin-Hastings Co., Inc., 226 Binney St. • Chattanooga 2, Tenn.: Poirson-Dookins Co., 823-824 Chattanooga Bank Bldg. • Chicago 32, Ill.: Lapham-Hickey Co., 3333 W. 47th Place • Elizabeth, New Jersey: A. B. Murray Co., Inc., Post Office Box 476 • Philadelphia 3, Penn.: Rutan & Co., 404 Architects Bldg. • San Francisco 10, Calif.: Pacific Metals Co., Ltd., 3100 19th St. • Seattle 4, Wash.: Eagle Metals Co., 3628 E. Marginal Way Toronto 5, Ontario, Canada: Alloy Metal Sales, Ltd., 881 Bay St. • Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.

high steam purity where it counts

Foster Wheeler Dual Circulation



Three FW Units for THE TEXAS COMPANY
LAWRENCEVILLE REFINERY
LAWRENCEVILLE, ILLINOIS

Steam Capacity
300,000 lb per hr

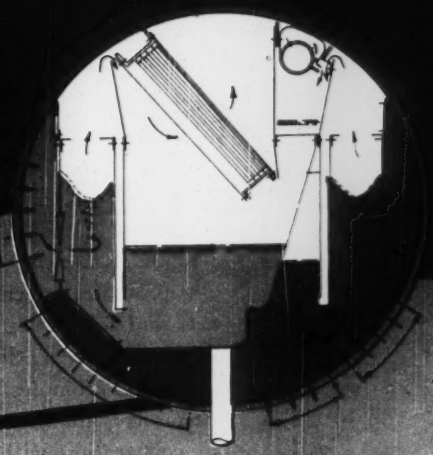
Superheat Control Range
150,000 to 300,000 lb per hr

Pressure Superheater Outlet
600 psi

Final Steam Temperature
750 F

Minimum Blowdown and Heat Loss

Steam Generators



Advantages for Both Central Station and Industrial Use

Under modern operating conditions of high pressure and temperature, the problem of steam purity is of increasing concern to the designers and operators of industrial and central station steam generators. Foster Wheeler engineers have successfully met this challenge by developing the Dual Circulation Steam Generator which already provides materially *higher availability, improved efficiency, and lower maintenance of high pressure steam turbines* at one large midwest refinery. Particularly in installations which have high makeup requirements, the Dual Circulation Steam Generator is capable of providing steam of higher purity with less blowdown than is possible in a conventional unit. In units operating on condensate, total solids and especially silica carryover are almost negligible with this design.

Design Features of Dual Circulation Steam Generator

The Foster Wheeler Dual Circulation Steam Generator consists of two separate heat absorbing sections each with its own independent circulating system. The feedwater goes to the primary, high duty, radiant heat absorbing section, which is continuously blown down into the low duty secondary convection section. Most of the steam is generated in the primary section where silica and boiler water concentrations are low. Thus, a marked reduction in the amount of silica carryover in the steam to the prime mover is achieved and tube damage is held at a minimum.

The Texas Company Orders Three Units for Lawrenceville Refinery

Because of adverse water conditions at the Lawrenceville Refinery, The Texas Company ordered three units, designed for high makeup with high concentration in its makeup. The Lawrenceville project is part of the present construction program in which all crude units are being engineered and constructed by Foster Wheeler.

For further information, write:

FOSTER WHEELER CORPORATION, 165 BROADWAY, NEW YORK 6, NEW YORK

FOSTER WHEELER

TO THE MEMBERS OF———

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Members of the A.S.M.E. are invited to name any number of engineers as candidates for membership. Engineering acquaintances should be qualified by both fundamental training and experience for one of the technical grades. An engineering degree is not a requisite but the equivalent in actual practice may be shown. Executives of attainment in other branches of science and industry may affiliate as Associates.

THE American Society of Mechanical Engineers promotes Mechanical Engineering and the allied arts and sciences, encourages original research, fosters engineering education, advances the standards of engineering, promotes the intercourse of engineers among themselves and with allied technologists; separately and in cooperation with other engineering and technical societies, works to broaden the usefulness of the engineering profession.

As a continuation school of engineering, the Society brings engineers into contact with each other, with leaders of thought and with new developments; it fosters the interchange of ideas, develops professional fellowships, and encourages a high standard of professional conduct—all with the purpose of advancing civilization and increasing the well-being of mankind.

C. E. Davies, Secretary
The American Society of Mechanical Engineers
29 West 39th Street, New York 18, N. Y.

Date.....

I suggest that an application and information regarding A.S.M.E. be sent to the following:

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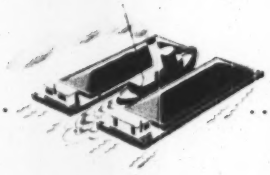
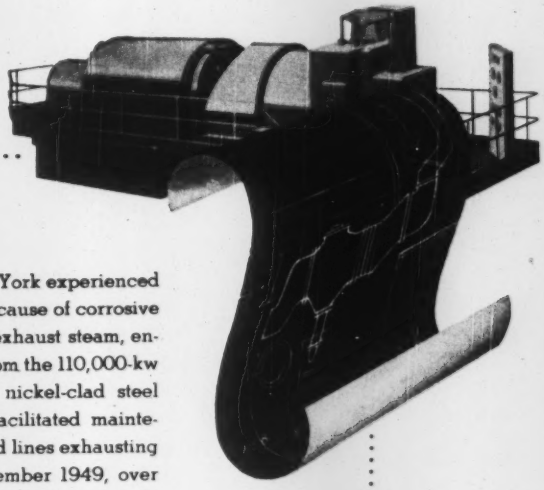
ME-5-50

ONE OF A SERIES DEMONSTRATING APPLIED LUKENOMICS

DEDUCTING MAINTENANCE

...or how to insure long life in high-temperature exhaust ducts

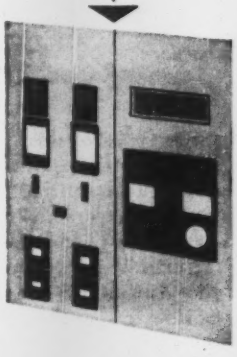




A Consolidated Edison Company plant in New York experienced costly failures in atmospheric exhaust ducts because of corrosive and erosive action developed in discharging exhaust steam, entrapped gases and chlorinated salt tidewater from the 110,000-kw turbines and auxiliary equipment. In 1946, nickel-clad steel ducts were installed. Their modern design facilitated maintenance by permitting shorter flanges for two feed lines exhausting from the auxiliary lubrication pumps. In December 1949, over three years later, the ducts were found to be in excellent condition, and savings had more than returned original installation costs

Such strides in equipment design in the last two decades have resulted in increased efficiency . . . lower maintenance and operating costs . . . improved performance. Many of the improvements have been the result of the cooperation between engineer, designer, fabricator and materials supplier. We call this *Lukenomics*. Such an approach is at your disposal to help solve your cost and amortization problems along with other vital considerations.

To obtain the advantages of equipment built by fabricators applying the Lukenomics principle, write our Manager of Marketing Service, Lukens Steel Company, 402 Lukens Building, Coatesville, Pennsylvania.

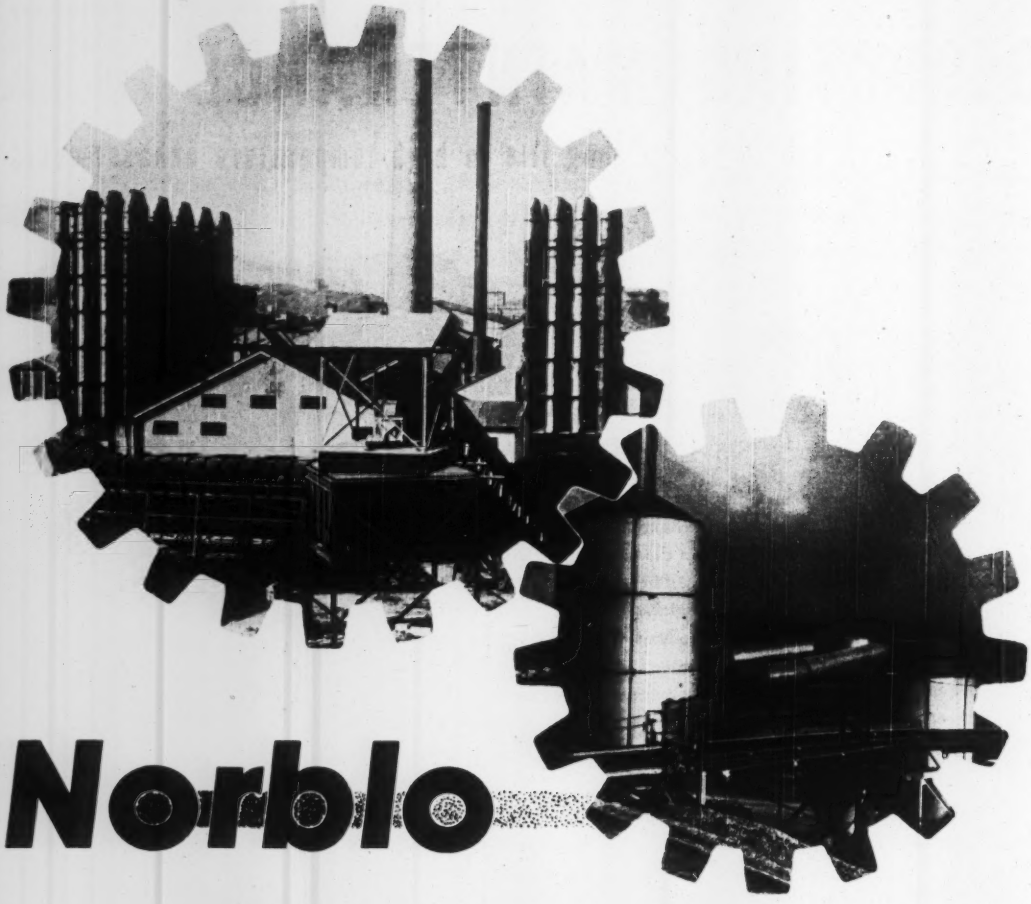


A nickel working surface is so satisfactory for exhaust duct service that Consolidated Edison Company of New York is standardizing on this design. For maximum economy the ducts are fabricated of Lukens Nickel-Clad Steel.

LUKENS

LUKENS STEEL COMPANY

BETTER PRODUCTS FOR BETTER EQUIPMENT



Norblo

Heavy Duty

DUST AND FUME COLLECTION

With three types of dust collectors — automatic bag, centrifugal and hydraulic — Norblo installations are geared to the heavy duty requirements of the smelting, mining, cement and rock products, foundry, chemical and milling industries.

Norblo Automatic Bag Type dust and fume collectors are outstanding in performance in continuous operation. These units are adjustable for varying dust load without shutting down. The periodic short cycle cleaning, automatically controlled, insures sustained collection efficiency at maximum. May we send you a handy Norblo Airflow Calculator — no obligation.

The Northern Blower Company

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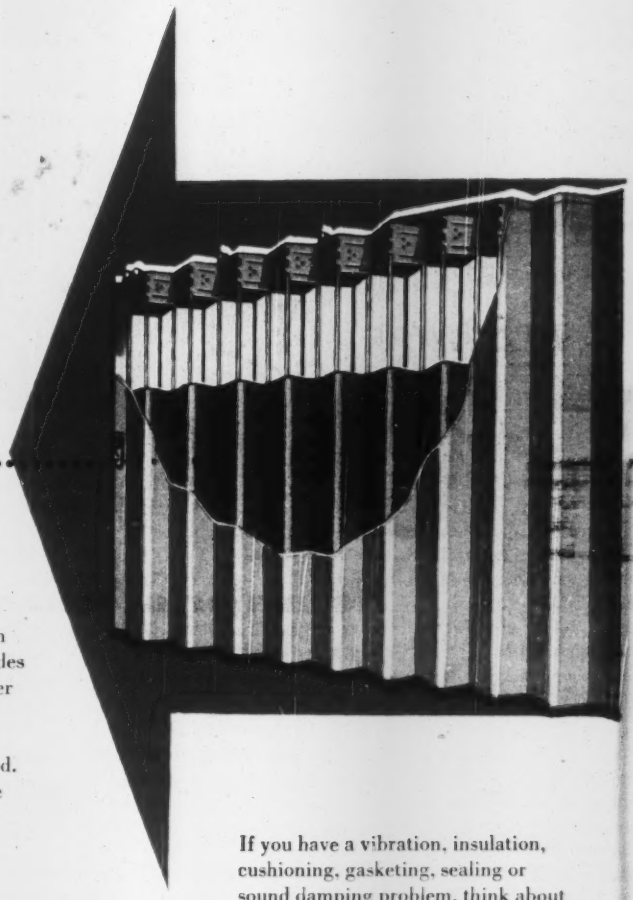
Automatic and Standard Bag Type Fume and Dust Collectors • Norblo Centrifugal and Hydraulic Collectors • Cement Air Cooling Systems • Exhaust Fans

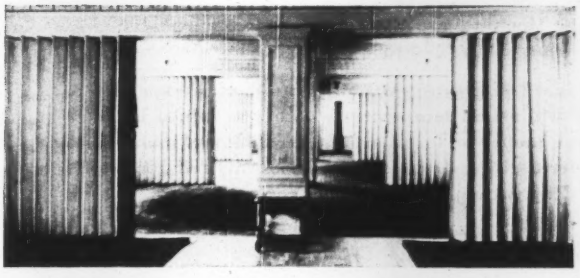
To an imaginative design engineer...

Spongex®

cellular rubber *sound insulates Modernfold Doors.....*



New Castle Products make the Modernfold accordion-like partition and closure which temporarily divides large rooms into two or more smaller ones. A sound retarding lining for installation in schoolrooms, offices and hotel banquet rooms was needed. In addition to deadening sound, the lining had to be flexible, durable, lightweight, small in bulk, free of dust and dirt, and economical. Spongex cellular rubber, in sheet form, answered their every need.



If you have a vibration, insulation, cushioning, gasketing, sealing or sound damping problem, think about *Spongex*. Cellular rubber does not become a "product" until you make it one in *your* application. We welcome new problems.

Technical Bulletin on Sponge Rubber available upon request.

The World's Largest Specialists in Cellular Rubber

SHEETS • CORDS • TUBING • STRIPS • MOLDED OR DIE-CUT SHAPES AND FORMS.

THE SPONGE RUBBER PRODUCTS COMPANY

301 Derby Place, Shelton, Conn.

AT SCHRAFFT'S ....

No major overhaul in 20 years

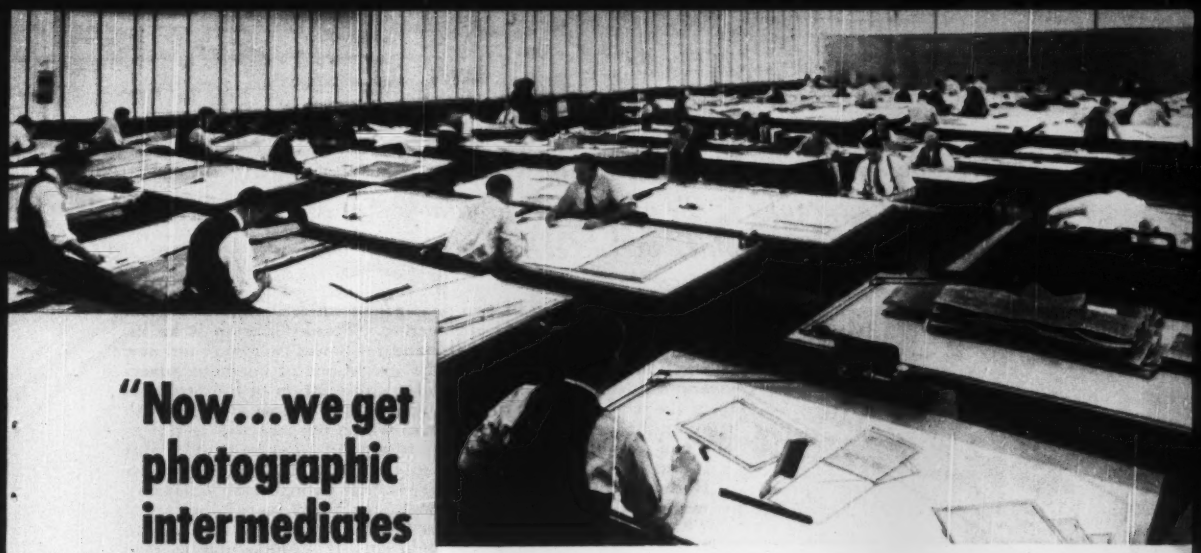
The two 200-ton Carrier Centrifugal Refrigerating Machines up front in the photograph cool water to 37 degrees F. for W. F. Schrafft & Sons Corporation, makers of fine chocolates. The two 75-ton machines at the rear cool brine to a temperature of 15 degrees F.

These machines and one other were installed in 1928. Not one compressor has needed anything but inspection and maintenance at bearings, shaft seals, and minor wearing parts.

That's what we mean by "minimum maintenance." And Carrier Centrifugal Refrigerating Machines are setting records for dependable operation in scores of meat packing and food processing installations.

The Carrier Centrifugal Refrigerating Machine is available in capacities up to 1200 tons. It will attain temperatures as low as minus 100 degrees F. It can save you money on installation, operating and maintenance. See your Carrier engineer or distributor about any refrigeration problems. Carrier Corporation, Syracuse, New York.

Carrier **Air Conditioning • Refrigeration • Industrial Heating**



A section of the engineering department—The Heald Machine Company, Worcester, Mass.

"Now...we get photographic intermediates quickly, economically"

reports

THE HEALD MACHINE COMPANY

Since 1947 the production of photographic intermediates has been easier, faster, more economical for The Heald Machine Co. *Thanks to Kodagraph Autopositive Paper.*

With this revolutionary, low-cost intermediate material, positive photographic copies of original drawings are produced *directly*—without a negative step.

Furthermore, Heald uses its direct-process machine for the exposure operation; standard photographic solutions for development. And there's this convenience, too: darkroom handling is a thing of the past! Both operations are performed under ordinary room light.

How "Autopositive" is used: A large percentage of the precision finishing machines manufactured by Heald are specially engineered to customer-specifications. And, frequently, Heald is requested to draw special units and fixtures on the customer's own drafting paper. These originals are reproduced on "Autopositive" (for Heald's record) and turned over to the customer when the job is completed.

Thus, when repair parts are requested or a duplicate order is entered, shop prints can be made promptly from the Autopositives. These new intermediates have dense photographic black lines on an evenly translucent base . . . will not smudge or smear in print production . . . turn out sharp, clean prints at uniform, practical machine speeds.

Kodagraph Autopositive Paper

"THE BIG NEW PLUS" in engineering drawing reproduction

- **It enables you, or your blueprinter, to produce positive photographic intermediates *directly* . . . at a new low cost.**
- **It preserves valuable original drawings . . . cuts redrafting costs.**
- **It restores old, soiled drawings . . . gives you cleaner, sharper prints.**
- **It gives you "photo-lasting" file copies, which will not curl, turn yellow, or otherwise deteriorate.**

A new illustrated booklet, "Modern Document and Drawing Reproduction," gives all the facts on this revolutionary photographic intermediate material. *It's free. Just mail the coupon.*

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EASTMAN KODAK COMPANY
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Please mail a free copy of "Modern Document and Drawing Reproduction"—your new booklet on Kodagraph Autopositive Paper.

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TO THE ENGINEER

whose success lies in his relationship with and understanding of people the study of biography is one of the most profitable that can be undertaken. Here are three biographies of successful engineers well worth reading.

Frank and Lillian Gilbreth: Partners for Life

This is the story of two people who made such a wonderful partnership of life and engineering. Frank Gilbreth is an inspiration to any professional man; for it was he who found new ways in old surroundings. His inventions of concrete mixers and adjustable scaffolds, his early appreciation of the problems of the workmen, and his keen concern for ethical relations with the public—stamp him as a man whose purpose was to put as much into life as he could, not to get out what he could. But it was the partnership which so greatly multiplied the productivities of each of the partners—which wrought the science of motion study—and which brought forth and reared the family whose hilarious story "Cheaper by the Dozen" has so skillfully been related by two of the children. It is impossible to read the story of this perfect partnership and of Mrs. Gilbreth's valiant continuation of her husband's work after his death, without realizing that both partners had inquiring, energetic, and constructive minds to an unusual degree. $5.50

Not only engineers, but all who aspire to eminence in a profession, can derive the highest inspiration from a study of the partnership of the Gilbreths ..... Mechanical Engineering

Scientific Blacksmith

The Autobiography of Mortimer E. Cooley, Dean of Engineering, University of Michigan. This is the story of the country boy who wanted to go down to the sea in ships, but whose long and useful life was devoted to education, to the advancement of the engineering profession, and to public service. The chapters devoted to his teaching days at the University are of peculiar interest, for Cooley lived for sixty-three years continuously at Michigan, and saw the College of Engineering grow from crude beginnings to the great institution it is today. His reflections and opinions on the engineer and the future also hold considerable interest for the engineers of today. These memoirs, written when he was past eighty, reflect a breadth of experience achieved by few engineers. $3.75

His zest for life is well reflected in the many anecdotes he tells and the zesty character of his writing ..... *Faults he had, like all of us, but, as Samuel Johnson said of Oliver Goldsmith, "Let none of his frailties be remembered, he was a very great man"* ..... Mechanical Engineering

The Autobiography of an Engineer

This book is of fascinating human interest, giving a vivid picture of William LeRoy Emmett. While Dr. Emmett is probably best known for his invention, design, and development of the mercury vapor-power system, he was also prominently identified with three other important phases of electrical development. These include the many types of apparatus and methods of distribution used extensively in the central station electric industry, the steam turbine electric apparatus, and the electrical propulsion of ships. Dr. Emmett's adventures as a young man, his life at the Naval Academy and at sea, and the tasks which engaged his attention during his long and active career combine to make his autobiography a truly dramatic story. $3.50

20% Discount to ASME Members

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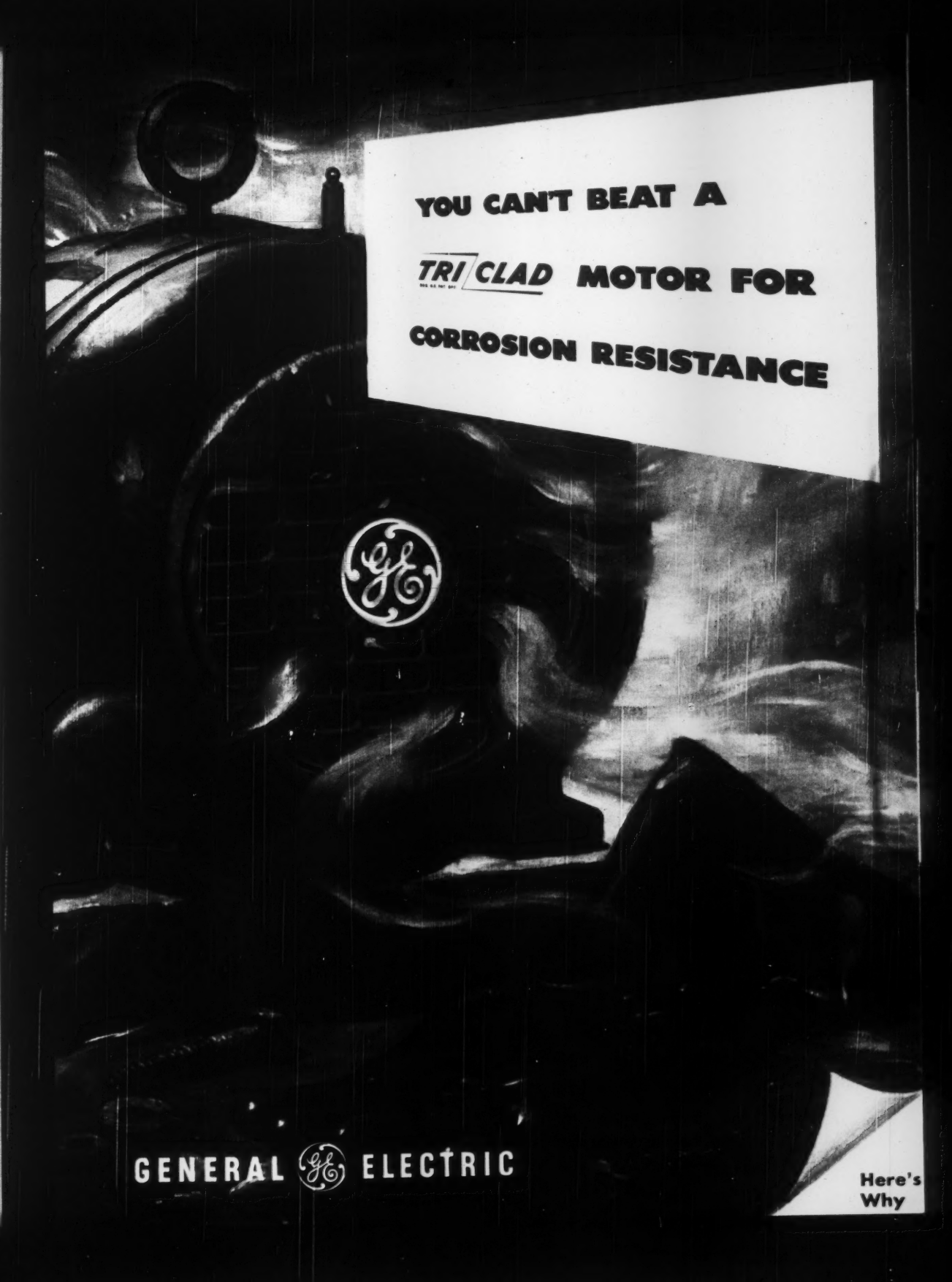
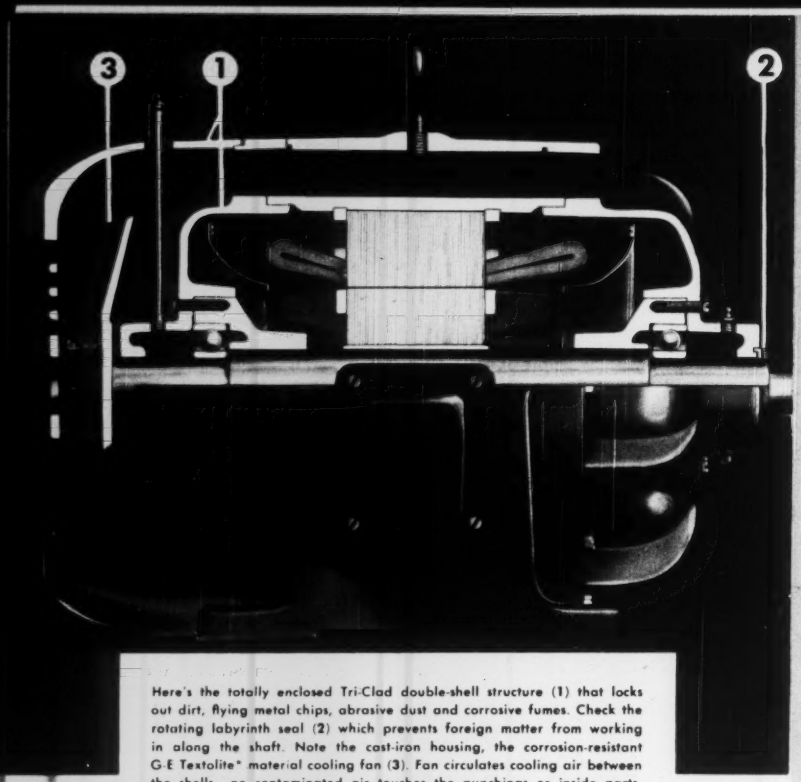
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 WEST 39TH STREET, NEW YORK 18, N.Y.


YOU CAN'T BEAT A
TRI CLAD MOTOR FOR
CORROSION RESISTANCE
GENERAL ELECTRIC
Here's Why



Here's the totally enclosed Tri-Clad double-shell structure (1) that locks out dirt, flying metal chips, abrasive dust and corrosive fumes. Check the rotating labyrinth seal (2) which prevents foreign matter from working in along the shaft. Note the cast-iron housing, the corrosion-resistant G-E Textolite* material cooling fan (3). Fan circulates cooling air between the shells—no contaminated air touches the punchings or inside parts.

You can't beat TRI CLAD motors for corrosion resistance

Acid fumes, alkali dust, dye-house vapors, tropical weather – you name *your* motor "poison." You just can't beat Tri-Clad cast-iron construction for corrosion resistance.

Rolling up 6 billion hours of service on all kinds of jobs, more than 1,876,000 Tri-Clad motors tell the eye-opening story of cast-iron motor structure. You get an inherent damping action that minimizes noise and damaging vibration. You get rigidity that makes for permanent shaft alignment. (Try bolting a Tri-Clad motor to an uneven surface – the bolt will snap before you can twist the rigid frame out of line.) You get extra protection against jarring blows and rough handling. You get resistance to rust and corrosion that is not approached by any other metal used for standard motor construction today.

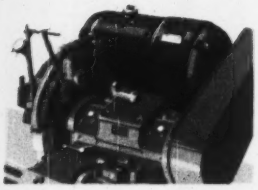
WANT MOTORS THAT STAY ON THE JOB ANWYHERE? There's a stock of Tri-Clad motors near you, in nearly all types and ratings, ready for **IMMEDIATE SHIPMENT**. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

*Reg. U. S. Pat. Off.

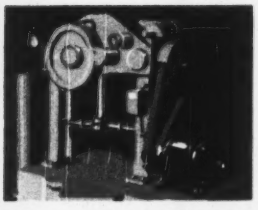
(standard on popular sizes)

YOU CAN'T BEAT TRI CLAD EXTRA PROTECTION

G-E capacitor motors for use on fans, blowers, pumps and compressors with single-phase power. From ¾ to 5 hp.



G-E Type ACA induction motors for adjustable speeds—provide speed ranges from 3-1 to 20-1. From 3 to 75 hp.



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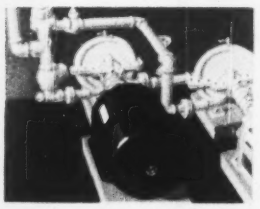

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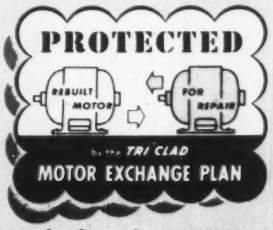

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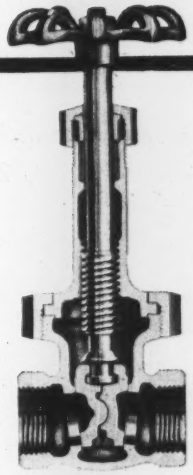
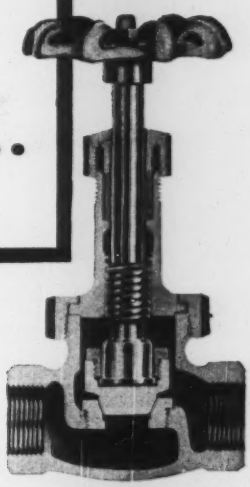


Walworth No. 29 Gate Valve



Walworth No. 225P Globe Valve
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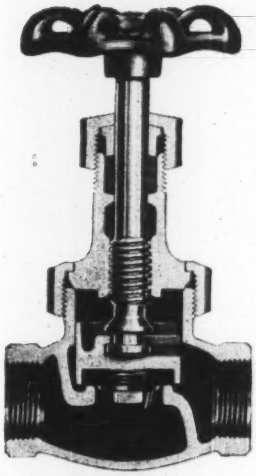

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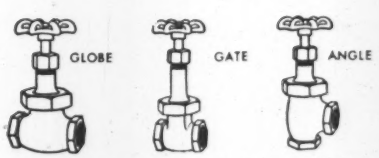

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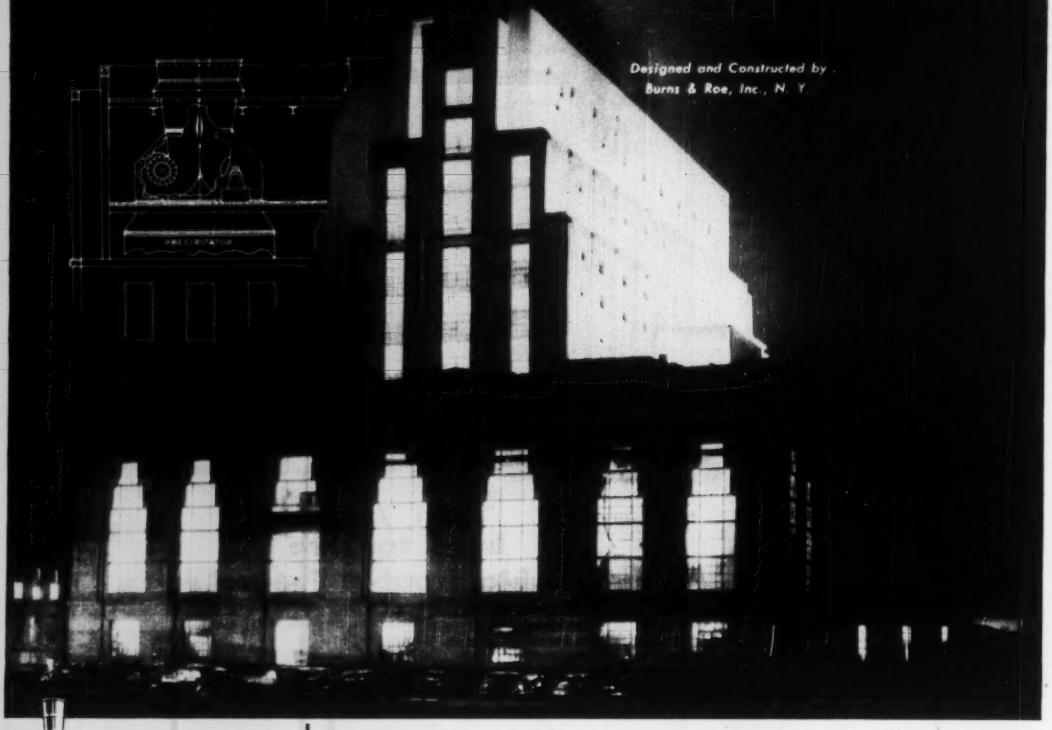

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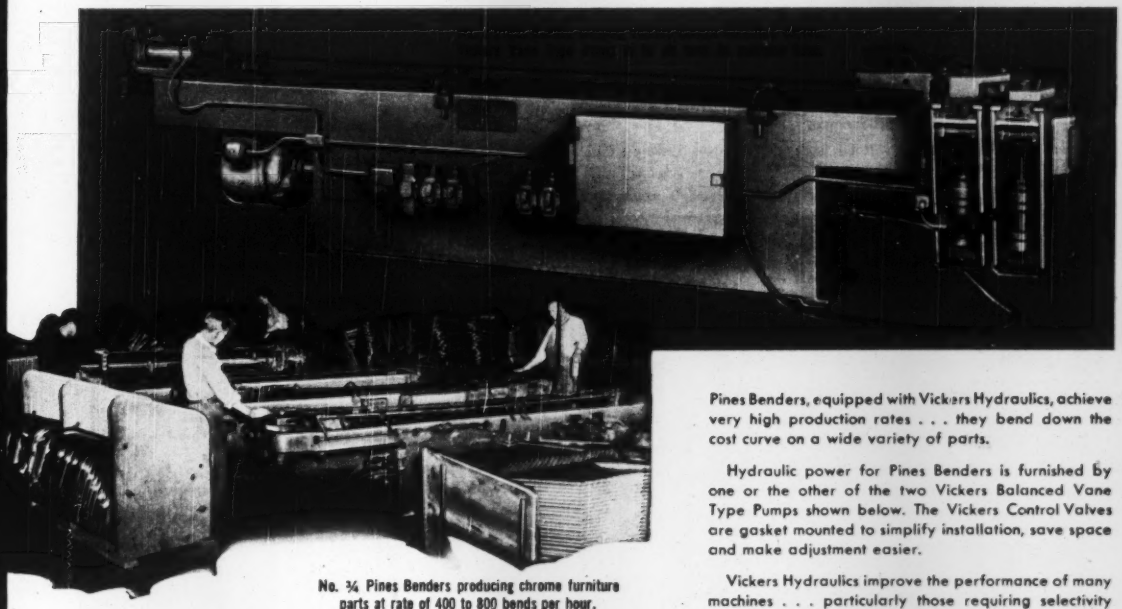

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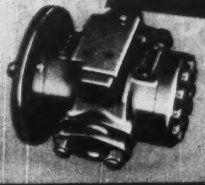

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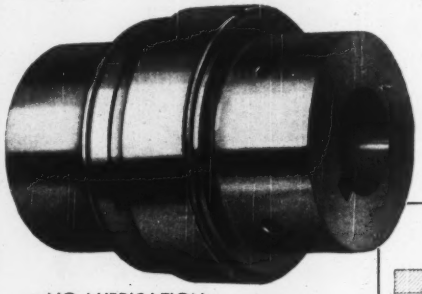

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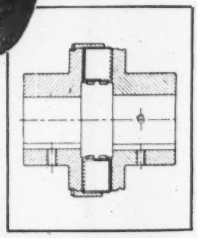

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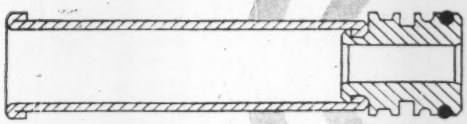

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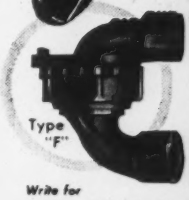

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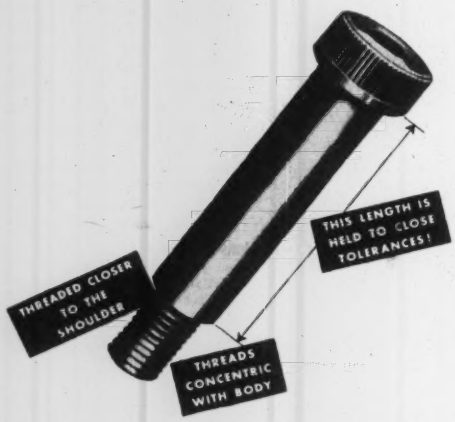

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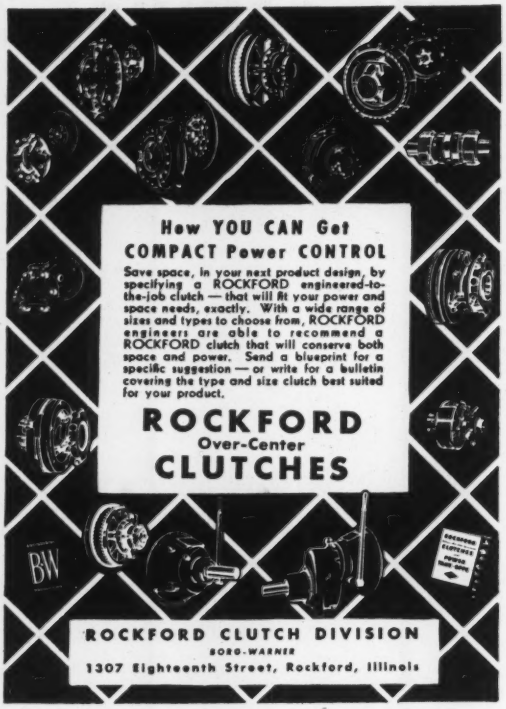
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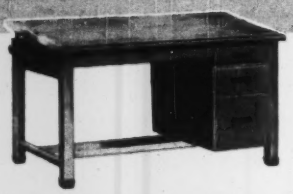

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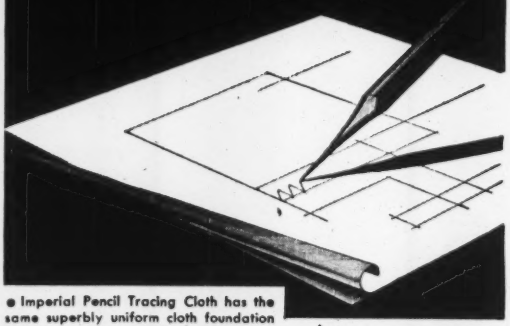

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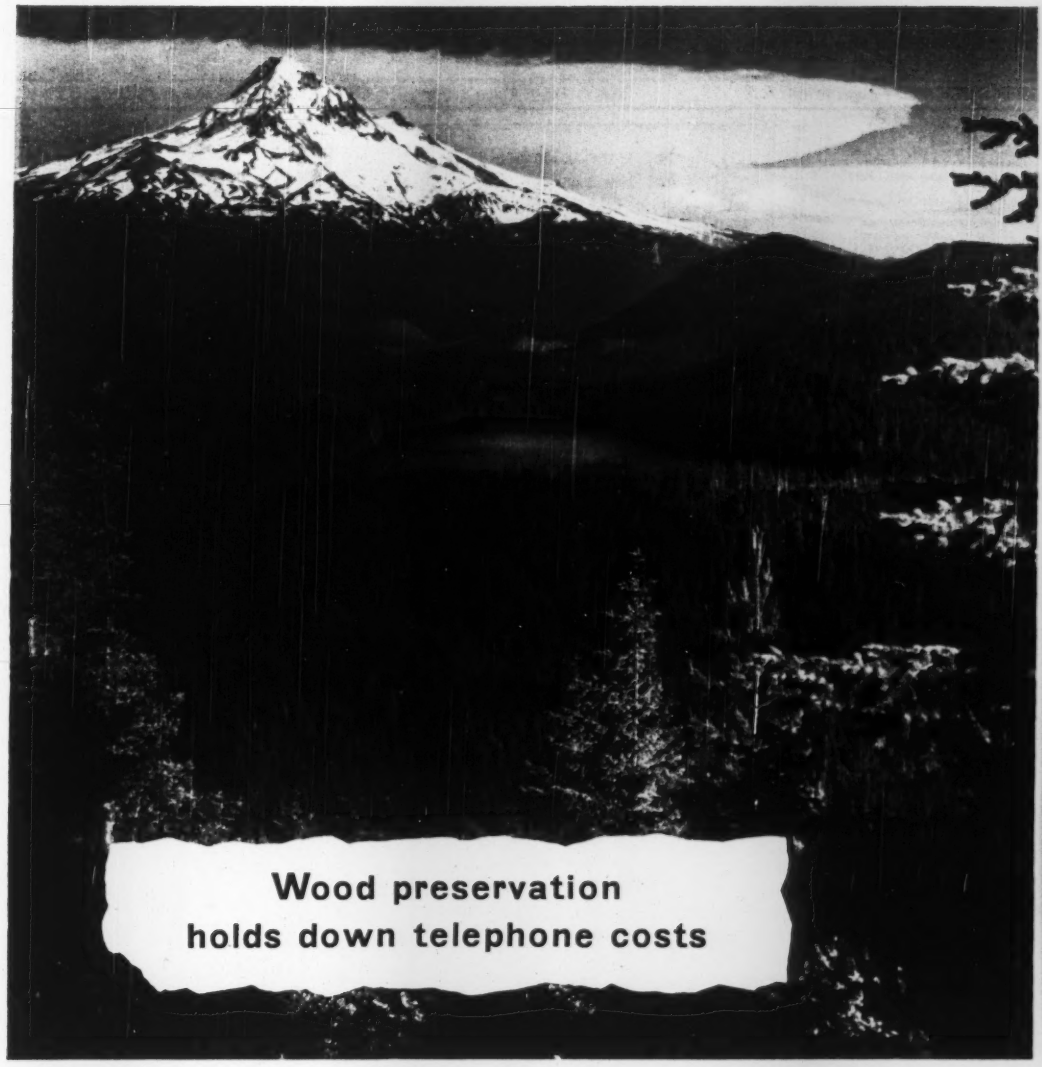

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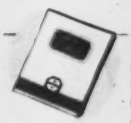

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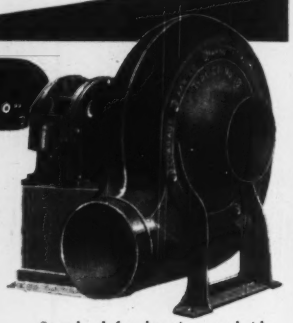
TYPE CI EXHAUSTERS

Capacities to 4000 CFM; Pressures to 20"



Nothing shoddy or flimsy about these smaller Clarage industrial fans. They are O.K. for continuous service — built to the *same exacting standards* as the largest Clarage equipment.

Try them! . . . then you will readily understand why we call them "HEAVY-DUTY" — *and mean just that!*

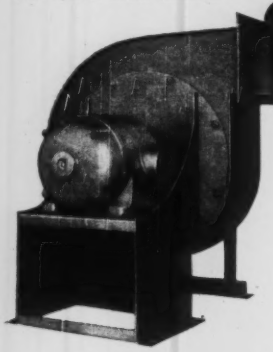
Use Clarage Type CI Exhausters for removing excess heat, dust, smoke, odors from any manufacturing operation — for supplying air to oil burners, as over-fire fans, etc. Use them for pneumatic conveying.

Fans also can be furnished gas tight, rubber covered, or with vulnerable parts of stainless steel or Monel — in fact, *in any construction* your special needs demand.

Standard fan housings and side plates are cast iron, long wearing, long resisting to corrosion. Heavy steel plate wheels are perfectly balanced. Fans in each of the 6 sizes can be V-belt or direct motor driven.

TYPE O BLOWERS

Capacities to 30,000 CFM; Pressures to 35"



Another Clarage HEAVY-DUTY industrial fan! Use Type O Blowers for *high pressure* applications — supplying air to cupolas, gas and oil burners, etc. Fan housings and wheels are heavy steel plate equal to severest conditions. Built in 19 sizes, operating at speeds *most economical* for direct motor or steam turbine drive.

WE ALSO MAKE:

LARGE INDUSTRIAL FANS
AIR CONDITIONING EQUIPMENT
AIR WASHERS UNIT HEATERS

CLARAGE FAN COMPANY – *Kalamazoo, Michigan*

CLARAGE

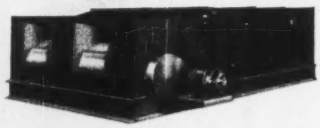
—HEADQUARTERS for Air Handling and Conditioning Equipment

SEE OUR CATALOG IN SWEET'S

It pays to direct fan inquiries our way . . . phone Clarage office in your city, or write us at Kalamazoo.

Application Engineering Offices in All Principal Cities

Wherever an Air CLEAN-UP is Required . . .



Clarage Capillary Conditioners Guarantee a Thorough Job!

Here are units that "wrap in a single package" the answers to (1) **maximum air cleanliness,** (2) **accurate temperature control,** (3) **close humidity regulation.**

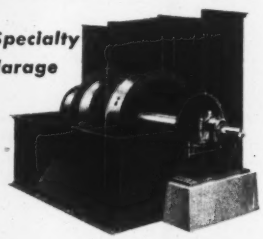
A Clarage Air Conditioner of this type includes a capillary cleaning section, pump, heating coils, fans, drive, and motor. Completely assembled — as either vertical or horizontal units — they install quickly and inexpensively. No additional parts or costly building alterations required. Seven sizes available — delivering from 1,800 to 20,000 cubic feet of air per minute.

Yes, where **thoroughly conditioned air** is vital to production, uniformity of product, health, or safety, there are many good reasons for choosing this modern equipment. Dependable performance is promised by scientific factory testing; **low first and operating costs** assured by Clarage's advanced engineering.

★ ★ ★

MECHANICAL DRAFT FANS

. . . a Specialty with Clarage



Recognized champions in the heavyweight class are these Clarage Fans for induced and forced draft service.

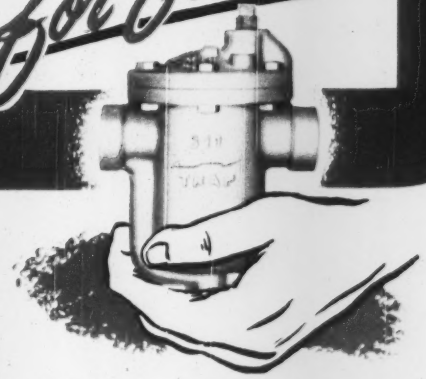
In thousands of central stations and industrial power plants Type RT Fans have proved **— and annually continue to prove —** their ability to withstand severest operating conditions. Shaft and bearings are EXTRA large; wheels EXTRA heavy; all points of stress HEAVILY reinforced!

Whenever air must be handled at high temperatures, high pressures, OR BOTH — for many industrial processes as well as in mechanical draft service — Type RT fans write outstanding performance records.

CLARAGE FAN COMPANY, Kalamazoo, Mich.

"How to get new steam traps for free"

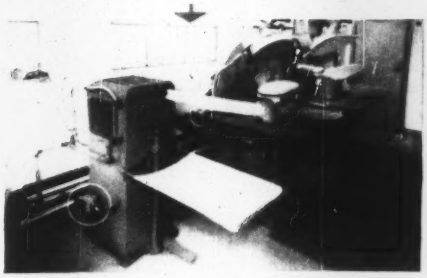
Trade steam losses for them . . .



Cost of Steam Leaks at 100 Pounds Pressure

(Assuming steam costs 50 cents per 1000 lbs.)

Size of Orifice	Lbs. Steam Wasted Per Month	Total Cost Per Month	Total Cost Per Year
1/2"	835,000	$417.50	$5,010.00
3/8"	470,000	235.00	2,820.00
1/4"	210,000	105.00	1,260.00
1/8"	52,500	26.25	315.00
1/16"	13,200	6.60	79.20
1/32"	3,400	1.70	20.40



Saves $59.62 MONTHLY — $98 for Armstrong Steam Traps cut the fuel oil consumption at *Wisconsin Cleaners*, Milwaukee, from an average of 1167 gallons per month down to an average of 625 gallons per month. The traps were better than "for free" — they pay back their purchase price more than seven times every year!

IT COSTS far more to live with leaky steam traps than it does to replace them with Armstrongs — the traps that pass no steam. Measure their cost against steam losses caused by traps that let steam get by (see left).

In Armstrong traps the discharge valve is water-sealed at all times—no steam gets to it. There's no chance for dirt to hold the valve open and let steam escape. Armstrong traps don't COST money, they SAVE money. Ask your nearby Armstrong representative to figure on the traps you need now.

ARMSTRONG MACHINE WORKS
894 Maple St., Three Rivers, Mich.

SEND FOR THE STEAM TRAP BOOK. It tells how to figure condensate loads, how to select traps. Includes prices, data, capacities of Armstrong Steam Traps. Write for your copy.

ARMSTRONG STEAM TRAPS

Gray Co. mounts 1-ton spindle on TIMKEN® bearings for extreme accuracy

THE huge machine shown below is the new Gray 8″ Planer-Type Horizontal Boring, Drilling and Milling machine. Working heart of this machine is the 8″ diameter, 12′ long, 1-ton spindle, precision-mounted on Timken® tapered roller bearings.

Gray writes: "Extreme accuracy, prolonged life and great load-carrying capacity are the predominant requirements of this important application. That Timken bearings were selected is significant".

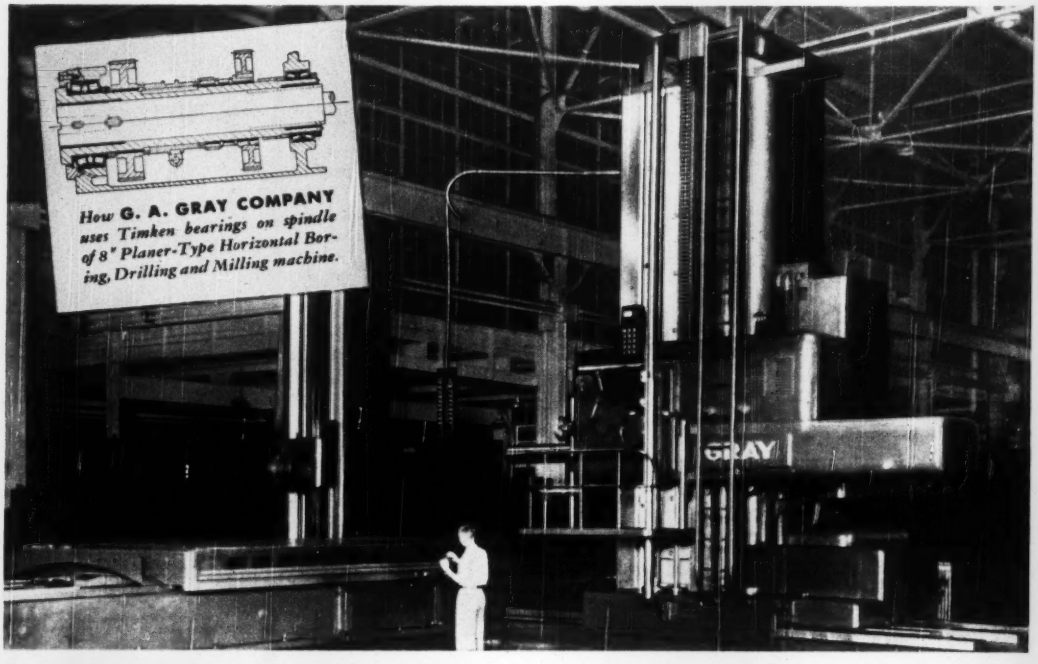
Timken bearings maintain extreme accuracy because they hold shafts in rigid alignment. They carry the toughest loads—radial, thrust and combination, thanks to their tapered construction.

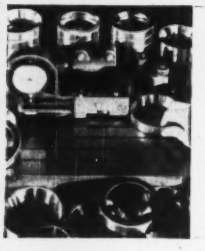
Timken bearings normally last the life of the machine because they're (1) engineered for the job, (2) made of Timken alloy steel, and (3) precision manufactured. Line contact between rolls and races gives them extra load-carrying capacity.

Friction is virtually eliminated by Timken bearings. Maintenance is held to a minimum. Operation is smooth and trouble-free.

You can make sure the machines you build or buy will have these advantages if you make sure they are Timken bearing equipped. Timken bearings are industry's first choice for the toughest jobs. Always look for the trade-mark "Timken" on the bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.


How G. A. GRAY COMPANY uses Timken bearings on spindle of 8" Planer-Type Horizontal Boring, Drilling and Milling machine.
GRAY



WITHIN ONE HALF A THOUSANDTH OF AN INCH!

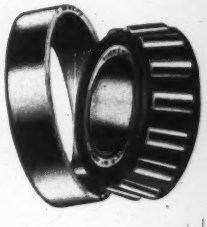
. . . that's an example of the accuracy demanded in the outside diameter of Timken bearing cups in order to pass inspection.

The Timken Company is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis Timken steels.

TIMKEN

TRADE MARK REG. U.S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ↓ AND THRUST →▯← LOADS OR ANY COMBINATION